Electrochemical Industry

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Electrochemical Industry

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ADVERTISING RATES GIVEN ON APPLICATION.

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THE BRUSH STORAGE BATTERY PATENT.

Secondary or storage batteries, consisting of lead and lead peroxide electrodes in sulphuric acid, were the first electric accumulators of any practical value. In 1856 Gaston Planté began his investigations, which extended over a period of several years, on the formation of accumulators of this type. His method of formation was purely electrochemical, starting with metallic lead, in the form of sheets, which he submitted to the action of an electric current in dilute sulphuric acid. His process was tedious and expensive, requiring a great number of reversals with intermissions of repose on short circuit. On account of the enormous expense of converting metallic lead into active material by this original Planté process, the *original* Planté battery cannot be said to have ever had a commercial existence.

On October 20, 1880, Camille A. Faure, a Frenchman, patented in France an improvement on the Planté battery, which consisted in mechanically applying active material to a conducting support, thus producing instantly a plate, the manufacture of which by the original Planté process required months. A corresponding patent was issued to Faure in the United States on January 3, 1882, No. 252,002. On March 2, 1886, United States patent No. 337,299 was issued to Charles F. Brush, Cleveland, Ohio, covering this same invention. After years of litigation and the expenditure of large sums of money, the United States Circuit Court of Appeals handed down a decision on October 4, 1892, in a suit of the Electrical Accumulator Co., owning the Faure patent, against the Brush Electric Co., owning the Brush patents. The court upheld the Brush patent, No. 337,299.

Some portions of this famous decision are of lasting interest, and are worth recording even at this late date:

> (3) The invention described in letters patent No. 252,002, issued January 3, 1882, to C. A. Faure, a citizen of France, for an improvement in secondary batteries, having been conceived by the patentee in France, and being covered by a French patent issued October 20, 1880, he cannot claim the invention in this country prior to the latter date, as against a citizen of the United States who, being an original inventor, subsequently received an American patent.
>
> (5) Brush's patent, No. 337,299, was not anticipated by the patent of April 3, 1866, to George G. Percival, for secondary-battery electrodes, consisting of cells filled with coarse conducting powder and divided by a porous partition; or by the patent of April 23, 1867, to George L. Leclanche, for a "polarization apparatus or electric accumulator," consisting of two plates of graphite or unoxidizable metal buried in two flasks of powdered graphite moistened with a liquid which is a good conductor, such as potash water.
>
> (9) The Brush patent, No. 337,299, was not invalidated by patents Nos. 260,653 and 276,155, issued to him prior to 1886 for improvements subsidiary to the main invention, for their subsidiary character appears on the face of such patents, although, owing to delays in the Patent Office, they were issued before the patent for the main invention.
>
> (10) The Brush patents, Nos. 337,299 and 260,090, did not expire with the Italian patent issued to him August 8, 1882, for division D of the Italian patent was designed to cover, not the

main invention, but Brush's invention, made in 1882, of plates specially prepared for the purpose of more rapidly forming active material thereon by the Planté method of electrical disintegration.

(11) The Brush patent, No. 260,090, must be limited to electrodes on which the active material is made by applying the Planté method of electrical disintegration or other "forming" process to plates which are ribbed, honey-combed, studded or equivalently prepared.

(12) When an inventor makes a generic invention, and also subordinate specific inventions, and presents the whole series in a set of contemporaneous applications, he cannot be allowed, by subsequent amendments, couched in general terms, to enlarge the boundaries of each invention so as to extend each into the borders of another, and thus obtain a series of overlapping patents.

Patents Nos. 260,653, 260,090 and 276,155, referred to above, were patents issued to Brush for subsidiary improvements prior to the issue of his broad patent, No. 337,299, in 1886. It was held by the defendants that division D of an Italian patent, issued to Brush on August 8, 1882, disclosed the invention claimed in Brush's broad patent of 1886. This claim was overruled, as shown above. Had this defense been successfully maintained, the Brush patents would all have expired in this country August 8, 1887, or about a year after the issue of the principal patent.

Immediately after the issue of the Faure patents, and as a consequence of the notoriety given to the invention by Lord Kelvin's sensational announcement that he could hold in his hand in a small box 1,000,000 foot pounds of stored energy, the field of storage-battery research became the most extensively worked of any subject of electrochemistry. Hundreds of inventors began to work all the probable changes of form in the "grid" or conducting support. An idea of the activity in this field may be obtained by considering that prior to the Faure patent, No. 252,002, there had been issued in the United States in the whole only nine patents on storage batteries. In the first year following the issue of the Faure patent 27 United States patents were granted on this subject; in the second year 43, and in the following years 37, 25, 23, 18, 50, 93, 92, 36, 43, 35, 32, 28, 30, 42, 27, 45, 53, 52, 94. The last figure refers to a little more than a year, as it comprises all patents issued since January, 1902, up to date. It will be seen that there was an immense activity immediately following the Faure patent, and that, while this activity was greatly abated during the period of litigation, there has not been a year in which the number of patents issued was less than twice the total number issued prior to the Faure patent.

The commencement of litigation, involving the mechanical application of active material to a conducting support, caused attention to revert again to the Planté method of formation, it being desired to find some method of avoiding the Faure and Brush claims without the expense and waste of time necessitated by the original Planté method. It was soon found that the corrosion of metallic lead with the formation of active material not mechanically applied could be accomplished in a comparatively short time, and even in a few minutes, by using oxidizing electrolytes instead of sulphuric acid, or in addition to sulphuric acid. It was found also to be practicable to convert the metallic lead by purely chemical means, without an electric current, into active material, which was equally adherent and efficient with the mechanically applied.

These discoveries, it will be seen, practically disarmed the owners of the Brush and Faure patents, hence it does not seem probable that the recent expiration of the Brush patent, No. 337,299, will have any very marked effect upon the commercial aspect of the storage battery. This is particularly shown in the fact that the leading storage-battery company of this country, and the one which has controlled the Brush patent, have for a number of years, to a large extent, abandoned the mechanical application of active material.

It has been found by the company referred to that for most purposes positive plates made by a modified Planté or electrochemical process, and negative plates made by casting a grid around a compound of lead, and subsequently reducing the same, have been more satisfactory than the mechanically applied or "pasted" type. It is worthy of note in this connection, however, that one of the most recent and apparently successful types for the specific purpose of operating automobiles is of the pasted type which has now become public property. There is no telling what effect the expiration of the Brush patent may have on the commercial development of this particular type of batteries for automobile purposes.

PROGRESS IN ELECTRIC-FURNACE WORK.

It is a curiously persistent and recurrent feature in the development of almost all new arts that after the disclosure of the new field paths are found leading into it from every direction, and the feeling is rather one of wonder that it remained so long undiscovered than of surprise at its discovery. Thus, after the development of the first reproducer of speech, it became apparent that a wide range of devices, from the arc to the electroplating vat, could be so manipulated as to produce the effects. Again, the discovery of new sources of the Becquerel rays and allied emanations have proceeded apace, until it would almost seem that in the end their presence will be detected wherever energy is undergoing transformation.

The history of the rise of the carbide art is an instance in point. The carbides of iron had long been known, and that of aluminium was discovered in the early days of electrometallurgy. Later the investigations of Moissan discovered a series so complete, so varied and yet so interrelated as to rival in theoretical interest any of the organic series. And now a very practical question with metallurgists is how *not* to get a carbide.

Among the abstract of current electrochemical patents in this issue is a description of a patent to Edward G. Acheson, which marks the solution of this problem for the case of aluminium, and perhaps of silicon. Of these, the former is readily obtained in a high state of purity by an electrolytic method, and the latter by any one of several special metallurgical processes. But the simple and brilliant conception that the carbon core of an ordinary electric resistance furnace may be eliminated from the equation, representing the reduction by means of a refractory heat-conducting sheath, and that for this sheath the most refractory carbides possess every essential qualification, seems destined to play an important part in electrometallurgy.

ELECTROCHEMICAL METHODS IN THE IRON AND STEEL INDUSTRY.

The greater the practical importance of a special field becomes in the development of an industry, and the larger the capital invested in enterprises of such a special field, the greater will be the tendency to differentiation and specialization on the part of the engineers and scientists interested in this special field. This is as it should be. It is a historical fact that the immense industrial developments of recent years were due to differentiation and specialization.

On the other hand, no special industry should lose sight of the development of its sister industries. The development of the whole is always bound to benefit the parts. Therefore, while specialization is the keyword of progress, every progressive engineer and scientist must keep himself informed of the progress in other fields in order to take advantage of it in his own special field.

We are glad to note that ELECTROCHEMICAL INDUSTRY, while primarily devoted to the interests of electrochemical engineers and scientists, is also read with steadily-increasing interest by the engineering world in general. In fact, it becomes more and more evident that there is really no branch of engineering which cannot in some way benefit from the recent developments of the art of electrochemistry.

The iron and steel industry has long become of such immense practical importance that it is now considered as a separate industry. There are many books and university courses on general metallurgy in which iron is not dealt with, because, on account of its practical importance, the iron industry is considered as a special metallurgical industry. Nevertheless most of the progress of this industry in recent years has been due to the fact that the most progressive managers and engineers in this field availed themselves of the possibilities offered by the development of other industries.

It is superfluous to speak at length of the wonderful progress which has been made in the iron and steel industry by the introduction of the use of electric power. We may simply refer to some remarks made by Mr. George Westinghouse in a recent speech in London, which was printed in our February issue. As an example, he stated that as a consequence of the progressiveness of the general manager of the Homestead Works of the Carnegie Co. in introducing electric power for any possible purpose, this company produce, with about 4,000 men, three times as much steel as the famous Krupp Works produce with 15,000 men.

The introduction of electric power in iron and steel works may become of immense importance for the introduction of electrochemical methods in such works. When electric current is available, the trial of electrochemical methods becomes an easy matter. The problem of melting iron and making steel in the electric furnace appears to be one of the most fascinating problems of modern metallurgy. Especially abroad, in France and Italy, a number of well-known metallurgists are endeavoring to find an economical solution of the problem. On the other hand, there are many who claim that, in view of the very high economy of the modern blast furnace, there is no danger, in the near future, of the electric furnace superseding the blast furnace. The principal question is, of course, that of cost, and it can readily be seen that the answer to the question whether it would pay to use an electric steel process will greatly depend upon local conditions, upon the cost of power and the cost of fuel. For the present we purposely refrain from discussing the general problem.

What we believe to be most needed at present for an understanding of the problem are facts on electric steel processes actually in operation. Such facts we intend to present to our readers in a series of articles, based directly upon authoritative information given by the engineers in charge of such work. In our January issue we dealt with a French plant using the Keller process; in our February issue we printed an article by Mr. Marcus Ruthenburg on his process, now worked at Lockport, N. Y., and in our present issue we publish an article on the Stassano process, in operation in Italy. We intend to continue this serial in future issues. Of the three processes so far described by us, the Keller process and the Stassano process apply the ordinary electric-furnace methods to the manufacture of steel, while the Ruthenburg process is interesting, as in it magnetic and electric means are combined in a decidedly novel manner to produce the desired results.

While we wish to refrain at present from discussing the principle of the use of electric-furnace methods in the iron and steel industry in general, we may emphasize the great advantages of such methods for the manufacture of special steels, such as tool steels. The present methods of manufacturing such special steels are expensive, and the advantages of electric-furnace methods for this special purpose are evident. It does not appear to be risky to prophesy that it is in this special field that the commercial invasion of electric-furnace methods in the iron and steel industries will be made.

Electric-furnace methods are, however, not the only electrochemical methods which will prove of importance in the iron and steel industries. An entirely different example of what electrochemistry can do for these industries is the Goldschmidt "thermite" process of producing high temperatures. The latest developments of this process, with applications to iron and steel, were dealt with in an article by Mr. G. P. Scholl in our January issue. True, the Goldschmidt process is a purely thermochemical process, but it must not be forgotten that it could become of practical importance only after the price of aluminium had been reduced by electrochemical methods. In fact, we have here a special case of the general rule that electrochemical methods enable us to store energy in chemical products, and that the energy thus stored may afterwards be used for other purposes. The calcium carbide and acetylene industry is another example of the same general rule. We may mention in this connection that in recent years calcium carbide has been tried in a similar way as a reducing agent in metallurgical processes. We mention these facts as a proof that the electrochemical methods in the iron and steel industries are not restricted to electric-furnace methods.

NEW YORK MEETING OF THE AMERICAN ELECTROCHEMICAL SOCIETY.

The third general meeting of the American Electrochemical Society will be held in New York City, April 16th, 17th and 18th.

Members and guests will please register at the Chemists' Club, 108 West Fifty-fifth street, and receive their badges as soon after their arrival as possible. Badges will be given to all members in good standing and to applicants who have deposited their initiation fee. Special badges will be provided for guests, who must be introduced by a member.

All meetings will be held in the large assembly hall of the Chemists' Club, where members in attendance may have their mail addressed, and where all announcements will be made.

By the courtesy of the Chemists' Club, its club house, including the library of the American Chemical Society, will be open for the use of members and visitors.

By the courtesy of the German Liederkranz, its club house, 111 to 119 East Fifty-eighth street, will also be open to members and guests during the convention. Membership buttons will secure admittance.

On Thursday morning, April 16th, at 9 A. M., a meeting of the Board of Directors will be held, which will be followed, at 10 A. M., by the business meeting of the Society, at which reports of directors and officers will be presented.

Reading and discussion of the following papers: Wilder D. Bancroft, Ph.D., "Constant Voltage and Constant Current Separations;" H. T. Barnes, Ph.D., "Experimental Study of Some Electrode Effects;" J. W. Richards, Ph.D., and W. S. Landis, "The Electrolysis of Water;" Wilder D. Bancroft, Ph.D., "Experiments with Metallic Diaphragms;" C. J. Reed, "Protective Action of Zinc Chloride on Metallic Iron."

At 1 P. M. luncheon will be served at the Chemists' Club, by invitation of the New York members. At 2.30 P. M. reading and discussion of the following papers: Max von Recklinghausen, Ph.D., "Insulating Materials—A Field for Chemists;" H. B. Coho, "A Historical Review of the Storage Battery," with illustrations; Elmer A. Sperry, "The Use of Pyroxyline in Electric Storage Batteries;" W. H. Walker, Ph.D., "The Concentration Changes in the Electrolysis of Brine;" J. W. Walker, Ph.D., "The Influence of Some Impurities in Salt Upon the Yield of Soda by the Amalgam Process;" A. A. Knudson, "The Corrosion of Metals by Electrolysis;" Titus Ulke, "Modern Electrolytic Copper Refining;" N. S. Keith, Ph.D., "A Note on the Composition of Electroplating Solutions;" C. W. Volney, Ph.D., "The Formation of Nitric Acid Under Electric Influences."

At 7 P. M., reception of members and guests in the clubhouse parlors of the German Liederkranz, 111-119 East Fifty-eighth street. At 8 P. M., subscription banquet for members and guests. Ladies are especially invited to participate. The price per cover is $5. A fine musical programme has been arranged.

Friday morning, April 17th, 9.30 A. M., announcement of the results of the election of officers for 1903. Reading and discussion of the following papers: W. D. Bancroft, Ph.D., "Note on Electrical Endosmose;" Louis A. Parsons, Ph.D., "Ions and Electrons;" Carl Hering, "Uniformity in Electrochemical Equivalent;" W. D. Bancroft, Ph.D., "The Electromotive Force of Alloys;" Prof. C. F. Burgess and Carl Hambuechen, Ph.D., "Electrolytic Production of Metallic Compounds;" J. G. Zimmermann, "The Electrodeposition of Metals Upon a Rotating Cathode."

At 1 P. M. luncheon will be served at the Chemists' Club, by invitation of the New York members.

At 2 P. M., excursions to plants and places of interest, as arranged by the Excursion Committee, starting from the Chemists' Club, where detailed notices will be posted.

At 8.30 P. M. the Society will, by special invitation, be the guests of the American Institute of Electrical Engineers at their extra meeting, held in the assembly hall of the Chemists' Club, at which the programme is as follows: President Scott, "Introduction;" W. J. Hammer, "Radium and Other Radioactive Substances, and Certain Phosphorescent and Fluorescent Substances," "The Properties and Applications of Selerium," "The Treatment of Disease by Ultraviolet Rays."

On Saturday morning, April 18th, 9.30 A. M., the following papers will be read and discussed: A. B. Marvin, "Electrolytic Conduction Without Electrodes;" P. G. Salom, "A New Type of Electrolytic Cell;" H. E. Patten and W. R. Alott, "Potentials of Zinc in Aqueous Solutions;" Woolsey McA. Johnson, "Notes on Electrolytic Depositions of Nickel;" Alfred H. Cowles, "What is the Capacity of Molecules for Electric Charge in Electrolysis?" J. A. Steinmetz, "Exhibit of Aluminium Corrosion;" August Eimer, "Exhibit of New Apparatus."

At 1 P. M. luncheon will be served at the Chemists' Club, by invitation of the New York members.

At 2 P. M. excursions will be undertaken to plants and places of interest, as arranged by the Excursion Committee, starting from the Chemists' Club, details of which will be posted.

At 8.30 P. M., meeting in the Chemists' Club, Assembly Hall. Presidential address by President J. W. Richards, Ph.D.; Max von Recklinghausen, Ph.D., Demonstration of the Cooper-Hewitt lamp and rectifier.

At 10 P. M. a German-American smoker (Kneipe) will be held at the Chemists' Club, Assembly Hall, buffet, luncheon, refreshments by courtesy of the New York members. A jolly social evening is assured.

Transportation will be on the certificate plan. All members not residing in New York City should secure certificates when purchasing tickets, in order to get return at one-third rate.

The hotel headquarters of the Society during the convention will be at the Wellington, Seventh avenue and Fifty-fifth street, half a block from the Chemists' Club.

The local committee consists of the following members: Dr. C. A. Doremus, chairman; Alvis von Isakovics, secretary; W. S. Cameron, assistant secretary; G. C. Adams, C. Batchelor, C. S. Bradley, Wm. Hand Browne, Jr., Dr. C. F. Chandler, E. A. Colby, Dr. F. B. Crocker, Dr. G. Drobezy, R. A. Fliess, Dr. H. Foersterling, J. C. Hatzel, Dr. N. S. Keith, E. C. Klipstein, A. A. Knudson, Dr. Morris Loeb, W. N. McCoy, C. O. Mailloux, A. Monell, E. H. Mullin, H. N. Potter, Dr. M. von Recklinghausen, E. E. Ries, Dr. S. Sheldon, N. Tesla, W. D. Weaver, E. Weston, C. E. Whitney and Dr. F. G. Wiechmann.

The above elaborate programme shows that the local committee has spared no efforts to insure a full success of the meeting. The attendance promises to be even greater than at the Philadelphia and Niagara Falls meetings.

We are informed that Dr. Walter Nernst, the distinguished professor of electrochemistry at the University of Goettingen, Germany, is expected to be present at the New York meeting.

INTERNATIONAL CONGRESS FOR APPLIED CHEMISTRY.

As already noticed in these columns, the Fifth International Congress for Applied Chemistry will be held in Berlin, June 2 to 8, 1903. Section X is devoted to electrochemistry and physical chemistry.

The American committee for this section, as appointed by President Remsen, of the American Chemical Society, consists of Dr. C. A. Doremus, chairman, and Dr. W. D. Bancroft, Dr. C. F. Chandler, Dr. A. A. Noyes and Dr. Edgar F. Smith.

The fee for membership of the Congress is $4.85, and should be forwarded to Dr. H. W. Wiley, chief of the Bureau of Chemistry, Department of Agriculture, Washington, D. C. Members of the Congress are entitled to receive the full printed proceedings of the Congress.

NOTES ON A CLASSIFICATION OF ELECTRO-CHEMISTRY.

BY CLINTON PAUL TOWNSEND.

(I) INTRODUCTION.

As an art, electrochemistry is remarkable for the wide range of its applications and for its recent rapid growth. To one desirous of keeping abreast of the progress made, and of having at hand a key to the literature of the subject, the question of its classification is a very important one. The classification outlined below deals exclusively with the "art;" that is to say, with the technical applications of the subject, disregarding all matters appertaining solely to the theory. The subject-matter of batteries or electrochemical generators is also excluded, since no useful purpose seems to be served by including this sharply-defined and highly complex art under the general title.

The classification was developed, or rather was permitted to develop, during several years, while the writer was serving as examiner of the class of electrochemistry in the United States Patent Office, and in this capacity was mainly engaged in searching and abstracting the literature and the patents with reference to the question of novelty of applications filed. The system is properly referred to as having been permitted to develop for the reason that no effort was made to deliberately subdivide the art into mutually exclusive classes, into which all applications and literature references should be fitted. Such course would obviously be futile, for inventors and writers alike refuse to limit their efforts to the matters so included, but most persistently deal with subject-matter which is essentially marginal, thereby obliterating such divisional lines as may have been established. The course adopted was therefore to segregate from the main subject-matter certain definite classes, made by the inventors and workers themselves, and the limits of which they have shown no tendency to transgress. The classes so divided from the general subject-matter may be clearly kept, and the material not falling clearly into any of them is left to constitute a part of the "general art." From this residual general art it will be found that additional classes segregate in the most natural manner, as the attention of chemists is directed to one or another portion of the field. So, also, as the classes already formed become complex from the number and variety of references contained in them, it is found advisable to divide out as sub-classes the minor subjects wherein especial activity is displayed.

As stated above, matters relating solely to theory are disregarded, but this statement is to be understood as purely relative; for what is pure theory at one stage of the development may be closely related to and interwoven with the technics of a later stage. While the theory is disregarded in the classification proper, it remains as a part of the "general art," to be carried into the appropriate classes as its bearing upon technical progress is made clear. Many instances of this will appear in the following discussion of the classes.

The classification in general outline is essentially, but not exclusively, functional; that is to say, it is based upon methods of work rather than upon apparatus employed. In its subordinate divisions, however, the basis of classification is quite generally the article, compound or element to be produced.

No attempt is made to so define "electrochemistry" as to place any restriction upon the subject-matter included. Whatever falls within the limits of the sub-classes is obviously a portion of the art, and whatever bears thereon or possesses any analogy thereto may properly be included in the indices. The classification should be given the utmost elasticity.

The necessities of cross referencing will, in general, be quite apparent. Such classes as "alternating-current electrolysis," "colloidal metals" and "organic non-electrolytes in plating" consist largely of cross references taken from the plating classes, and methods of general utility, but specific application, may conveniently be placed under the sub-classes and cross referenced to the general class. As an instance of the latter, an author describes a method for determining the hardness of electrodeposited chromium. The data secured relate to chromium, and are properly included therewith, but the method, being equally applicable to all metallic deposits, is best classed under "aqueous bath."

No claim is made that the outline classification hereinafter given is the best; merely that it has proven in use to be convenient and elastic. The excellent service done for chemists in this country along bibliographical lines will undoubtedly be repeated in the near future for electrochemistry. In fact, several abstract bibliographies of special classes have already appeared. Meantime, however, the necessity devolves upon each electrochemist of arranging such material as he may have at hand in a manner permitting ready reference, and the suggestions here given are offered to this end.

(II) CLASSIFICATION OUTLINE.

- Electrochemistry.
  - General art.
  - Alternating-current electrolysis.
  - Aqueous bath.
    - Alloys.
    - Aluminium.
      - Deposition on.
    - Anodes.
      - Oxide coatings.
    - Apparatus.
    - Cathodes.
      - Metallizing.
        - Porous substances.
    - Chromium.
    - Colloidal metals.
    - Compounds.
      - Inorganic.
      - Organic.
        - Oxidation methods.
        - Reduction methods.
    - Copper.
    - Osmose.
    - Gold.
    - Haloids.
      - Bleaching and disinfecting liquors.
      - Chlorates.
      - Mercury cathode.
      - Treating cathode lyes.
    - Hydrogen and oxygen.
    - Iron.
    - Lead.
    - Nickel and cobalt.
    - Ores.
      - Gold and silver.
        - Cyanides.
        - Halogens.
      - Zinc.
    - Organic non-electrolytes in plating.
    - Pickling.
    - Pigments.
      - White lead.
    - Platinum and palladium.
    - Reduction by couple.
    - Refining metals.
      - Copper.
      - Nickel.
      - Regenerating electrolyte.
    - Silver.
    - Sulphates.
    - Tin.
      - Treating tin scrap.
    - Zinc.
  - Asymmetric conductors.
  - Carbon.

Depolarizing.
Diaphragms.
Electric furnaces.
Electric-furnace processes.
  Carbides.
    Calcium.
  Cyanides and nitrides.
  Diamonds.
  Graphite.
  Oxides.
  Phosphorus and phosphides.
  Reduction to metal by carbon.
  Silicon and silicides.
  Sulphides.
Fused bath.
  Aluminium.
  Sodium.
Magnetism—electrolysis influenced by.
Ozone.
Printing processes.
Purifying liquids.
  Alcoholic.
  Sugar solutions.
Solid electrolytes.
Solvents other than water.
Synthesis.
  Oxides of nitrogen.
Tanning.
Vacuum deposits.

(III) NOTES ON OUTLINE.

General Art.—This comprises the material not segregated into the classes which follow. It may not inaptly be likened to the complex mother liquor remaining after a series of separations. Discussion of its composition and the relation of residual matter which it contains to the matter separated is best deferred until after the consideration of the several classes.

Alternating-current Electrolysis.—This comprises all electrolytic methods based upon the use of an alternating current, irrespective of purpose or conditions. Purely thermal methods are, of course, excluded. The electrolytic alternating-current meters, measuring alternating currents by the loss of weight of electrodes in cells in shunt or induced circuits, are properly classified here, as are also such wave-registering devices as that of Janet. Other examples are the investigations of Sheldon and Waterman upon the sulphating of lead plates, and those of Roepper and Richards upon the production of insoluble sulphides. The synthesis of various organic compounds, pyrocatechin, hydroquinone and urea, fall under this class, as do also the investigations of Maneuvrier and Chappius on the decomposition of water and those of Gerdes and others on the attack of platinum electrodes in ammonium carbonate solutions. The observations of Burgess on the effect of alternating currents superposed upon direct currents in plating operations relate particularly to nickel, and should be classed with this metal, but are properly cross referenced into the present class. These examples and those which follow are not to be considered in any sense as a summary of the contents of the classes. Such summaries, for certain classes possessing particular interest or exhibiting especial activity, it is hoped to offer later. The present effort is rather to illustrate, by means of examples as diverse as possible, the limits of each class. It will be noted that all of the examples given refer to operations conducted in aqueous solution. This limitation is not imposed by the character of the class, but rather by the fact that investigations have not extended to the wider field.

Aqueous Bath.—It is partly an accident of development that renders this the most thoroughly studied and fully subdivided of the general classes, and the extent and character of the subdivisions will illustrate how completely the early growth of the art was associated with the study of salts in solution in water. The broad class of aqueous bath as here retained is distinctly *residual*, occupying precisely the position with reference to its sub-classes that the general art does to the art as a whole. The material classified therein is therefore such as is excluded from the sub-classes immediately following. In general, this may be said to comprise (1) data as to the separation of metals whose electrolytic production has not yet become of such technical importance as to warrant their separate classification, or with reference to which investigations hitherto published have touched only the analytical, as distinguished from the industrial side; (2) articles of broader bearing than the limits of any sub-class, typical examples of which are the papers upon the alloying of metals as a factor in electroplating and on the physical character of metal deposits in a recent issue of the Electrochemical Industry. Other examples are the work of Jordis on the influence of lactic and glycollic acids on the electrodeposition of metals, the abundant literature on the influence of pressure, temperature, etc., upon deposition, and in general any discussion of factors which have a similar or analogous effect in the deposition of more than a single metal; (3) phenomena not related to the plating operation, such, for instance, as the disintegration of metallic cathodes under high current densities and the electrolysis of salts, not otherwise classified, which yield no metallic ion, the idea being to confine the sub-classes designated by the names of metals to plating operations wherein these metals are separated, as metals or as oxides, at one or the other electrode.

FIG. 1.—1,200-AMPERE SWITCH.

Aqueous bath; alloys. The direct deposition of alloys from solutions of mixed electrolytes.

Aqueous bath; aluminium. The deposition of aluminium from aqueous solutions. This sub-class occupies an anomalous position, possessing the extended and confident literature, but being apparently quite innocent of practical achievement.

Aqueous bath; aluminium, deposition on. The peculiar surface of the metal necessitates particular methods of treatment for the formation of adherent deposits of other metals. This sub-class gives evidence of especial activity and substantial recent progress.

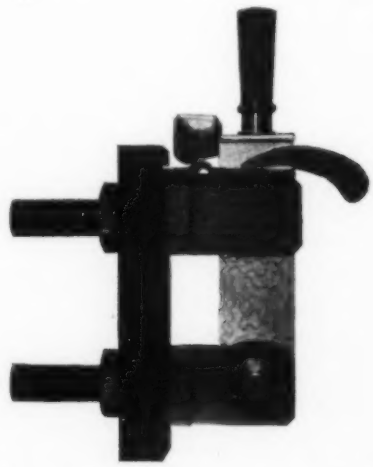


FIG. 2.—1,200-AMPERE SWITCH, WITH SECONDARY ARCING TIP.

Aqueous bath; anodes. The use of an anode is, of course,

common to all methods. This sub-class relates to anode design; their protection at the immersion line; special devices for insuring even current distribution; particular compositions and modes of treatment, and data regarding the life of anodes under specific conditions. The sub-class includes both polarizable and non-polarizable anodes.

Aqueous bath; anodes, oxide coatings. A compact and interesting class, relating mostly to coloring or "browning" iron and steel and the electrolytic imitation of the Russia effect in iron. The separation of metals, as peroxides for analytical and other purposes, not related to the treatment of the anode, is referred to the plating classes.

(To be continued.)

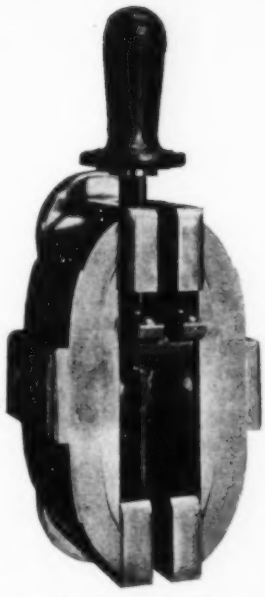
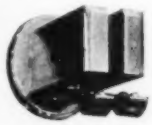


FIG. 3.—3,000-AMPERE 250-VOLT LAMINATED LEVER SWITCH.

LARGE CAPACITY SWITCHES FOR USE IN ELECTROLYTIC WORK.

By E. M. HEWLETT.

In electrolytic work there are two general methods of connection, the series and the multiple connections. The multiple method of connection necessitates low potential and large current-carrying switches, while the series method reduces the current capacity and increases the potential



The series method is preferable where it is possible, on account of the saving in size of copper conductors and switches. However, in cases where it is necessary to use the lower potentials and large currents, a switch of large capacity and low-contact resistance is required.

Considering first the smaller-capacity switches, up to 2,000 ampères, the lever type of switch, shown in Figs. 1 and 2, are generally used: These switches are made up with single blades in the smaller capacities, and in the large capacities with two or more blades in parallel. Fig. 2 shows this type of switch with a secondary arcing tip, which is intended to be used where the potential or the character of the load is such as to cause burning at the contacts.

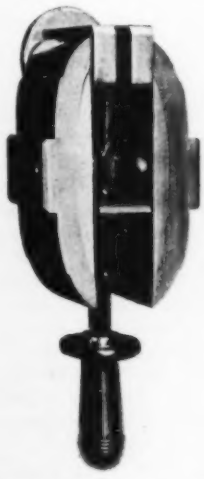


FIG. 4.—3,000-AMPERE 250-VOLT LAMINATED LEVER SWITCH.

The design is simple, in construction rugged, making a very serviceable switch. Considerable effort is required to operate this type of switch in capacities above 2,000 ampères.

For capacities above 2,000 ampères, and up to 4,000 ampères, the laminated lever type of switch lends itself better, on account of requiring less effort to operate and insuring good contact.

This switch is shown in Figs. 3 and 4, and is made up of a pair of bridging laminated contacts, embracing either side of the contact stud; and the design is such as to insure each individual lamination making separate and positive contact on the stud, thus making an excellent contact of very low resistance.

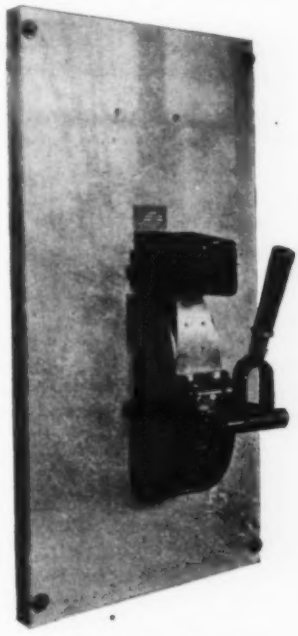


FIG. 5.—8,000-AMPERE SWITCH.

The laminated lever switches are fitted with secondary arcing tips to take the final break, consequently preventing all roughing of the main contacts due to the arc. These switches are made single, double and triple-pole, single and double-throw, and are made in capacities from 1,200 to 4,000 ampères.

In order to make a switch which would operate more easily in larger capacities, the laminated toggle brush switch was designed, as shown in Figs. 5 and 6.

This type of switch is more easily operated for a given capacity than any other, the contacts being of the laminated bridge type and forced in contact under pressure by a toggle. The laminated type of contact is particularly effectual on account of the characteristic of individual contact of the

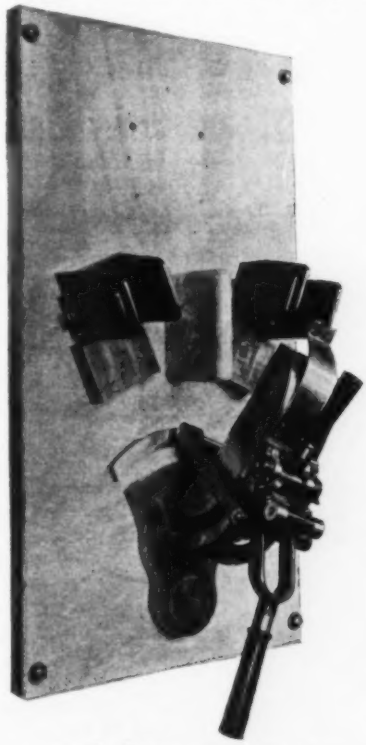


FIG. 6.—8,000-AMPERE SWITCH.

separate laminations. To insure this positive individual contact it requires a great amount of pressure. The toggle construction makes it possible to obtain this pressure with a minimum effort.

This switch is made in capacities from 2,000 to 12,000 ampères, is fitted with a secondary arcing tip, which protects the main contacts from the effect of the arc on rupturing, and is made single-pole, single, double and triple-throw.

NOTES ON THE HISTORY OF ELECTROLYTIC COPPER REFINING IN AMERICA.

By Titus Ulke.

In 1879 an experimental plant for refining copper by electrolysis was operated for a short time at Phœnixville, Pa., but the first commercial refinery in America was built by Edward Balbach & Sons at Newark, N. J., early in the 80's.

Up to about 1882 the precious metals were extracted from copper bullion in the United States by the sulphate of copper or vitriolisation process chiefly. With increasing supplies, however, the production very soon exceeded the consumption of sulphate of copper, and the necessity of utilizing another process became more and more obvious. This led to a trial of the electric current for effecting the separation by Messrs. Balbach at Newark, although a previous attempt in this direction, made at Baltimore, had turned out a failure and served as a warning against repetition.

Mr. Balbach, Sr., an excellent practical chemist, and his able son, Mr. Ed. Balbach, Jr., now president of the Balbach Smelting and Refining Co., entrusted Mr. F. A. Thum, a mining and metallurgical engineer, with the task of conducting the experimental work of the new process. The trials proving successful, an electrolytic refinery was erected in 1882-1883 and placed in charge of Mr. Thum, who still ably fills the position of its superintendent.

As it is with almost every case of pioneer work, the difficulties to overcome were many, and discouraging results were frequent at the experimental stage of the process. Under these circumstances, Messrs. Balbach certainly deserve much credit for not relaxing their efforts in continuing the comparatively expensive trials. Owing to the secrecy maintained by English and German refiners, it was next to impossible to obtain working data from them; nor did the patents of James Elkington, the father of electrolytic copper refining, disclose the desired information.

Upon Mr. Thum, therefore, devolved the task of working out the details, such as determining the proper energy of the current required per vat, the arrangement and size of the tanks and of the copper conductors, the way of suspending the electrodes, the production and preparation of the starting sheets and the composition and correction of the electrolyte. As a matter of fact, the rules established and appliances devised by Mr. Thum form the basis of the refining process now in general use, and have been adopted by nearly all American electrolytic copper works.

In those early days there were no voltmeters or ammeters on the market, it appears, and they had to be constructed by each experimenter under the then existing conditions. Apparatus based on the fact that the current from one Daniell cell had a sufficient voltage to drive it through three or four sulphate vats, according to the acidity and temperature of the electrolyte, and that the quantity of the copper deposited in a given time varied directly as the area of the electrodes, and could be increased up to the point where the current-furnishing dynamo began to overheat, at the start served as excellent guides.

The first dynamos used by Messrs. Balbach were furnished by the Excelsior Electrical Co., who were represented by Mr. Wm. Hochhausen, who also assisted in working out the process.

The problem of how to suspend the electrodes and make as perfect a contact with the conductors as possible, while reducing to a minimum the distance between electrodes and allowing the electrolyte to circulate freely, was satisfactorily solved by Mr. Thum by giving the anodes side lugs and their present shape and bending the cathodes over U-shaped suspension bars. At the same time the formula for the proper composition of the electrolyte and a quick and effective way of regenerating it, both of which are in general use to-day, was discovered. Thus, by the end of 1883, all the chief technical points in electrolytic copper refining were satisfactorily settled. The Balbach works, even at that early date, produced from 2 to 3 tons of electrolytic copper daily, but, as this production was soon considered inadequate, they were remodeled until they reached their present tonnage and high state of efficiency.

The refineries at Baltimore, Md., and at Anaconda and Great Falls, Mont., were not started until 1887, 1891 and 1892, respectively. In 1895 the Guggenheim refinery, now known as the Perth Amboy plant of the American Smelting and Refining Co., was built, and in 1898 ground was broken for the erection of the great Raritan Copper Works, Perth Amboy, N. J., and the current turned on in the tank house March 23, 1899, after an interval of less than eight months.

The 50-ton De Lamar electrolytic works were started March 14, 1902, and the new 100-ton tank house and equipment at the Perth Amboy plant (Guggenheim works), arranged according to A. L. Walker's improved design, were put in commission last year.

Sixteen years ago the Balbach and the Bridgeport, Conn., works were the only large electrolytic plants in America, and their output was less than 24 short tons of copper per diem. Yet to-day there are in operation ten electrolytic refineries, producing the enormous quantity of 705 tons daily, or about 257,000 tons of copper annually, besides over 25,000,000 ounces of silver and 318,000 ounces of gold.

REDUCTION FACTORS FOR ELECTROLYTIC DEPOSITS.

By Carl Hering.

As there are quite a number of different units or quantities in terms of which the amounts of substances reduced or formed electrolytically are expressed, it often becomes necessary or desirable to change from one unit to another. While many of these reductions from one to the other are comparatively simple, yet they always involve some labor and introduce the possibility of making an error. To avoid this, and to show at a glance what relations the units bear to one another, the following table of reduction factors has been calculated under the direction of the writer, and will often be found to be quite useful.

The table gives the value of each unit in terms of each of the others into which it is likely to be converted, so that in any case only one multiplication is necessary. Moreover, the reciprocal values are also given in most cases in their proper places, thus avoiding all long divisions. Approximate values have also been added, which are correct within 2 per cent., and are therefore sufficiently accurate for most practical purposes. These approximate numbers have been so chosen that they involve the least possible figuring, generally only a multiplication by a single digit, a division by another and sometimes the pointing off of some decimal places. This requires even less figuring than a multiplication by a value given in only two figures, which involves three rows of figures and an addition. Moreover, the error in using only two-figure values is variable, and may be as high as 10 per cent., while with these approximate values it is always within 2 per cent.

The figures are not a compilation, but have all been re-calculated from the legal weights and measures of this country (and with a very slight difference of Great Britain also), as used by the National Bureau of Standards in Washington. They have been carefully calculated and subsequently checked, and it is believed there are no errors. They are given in the order of

size. The year in the larger commercial units was taken as 365¼ days.

It will be noticed that there are a number of unsuspectedly simple and easily-remembered relations between a number of these units. For instance, 5½ pounds per day are almost exactly a ton (of 2,000 pounds) per year, or 5½ kilograms per day are equal to 2 metric tons per year. Every gram per minute is about 3 pounds per day, or nearly 1½ kilograms per day. A ton per year is about 1¾ grams per minute. A metric ton per year is about 6 pounds per day, or ¼ pound per hour. Other similar relations may readily be found from the table:

1 pound (av.) per year *(lb./yr.)* equals:
- 0.002738 pound per day.—Aprx. 11/4 ÷ 1,000.
- 0.0008624 gram per minute.—Aprx. 6/7 ÷ 1,000.

1 kilogram per year *(kg./yr.)* equals:
- 0.006036 pound per day.—Aprx. 6 ÷ 1,000.
- 0.002738 kilogram per day.—Aprx. 11/4 ÷ 1,000.
- 0.001901 gram per minute.—Aprx. 19 ÷ 10,000.

1 gram per hour *(g./hr.)* equals:
- 1/60 or 0.01667 gram per minute, which see for other values.

1 milligram per second *(mg./sec.)* equals:
- 0.06 gram per minute, which see for other values.

1 pound (av.) per day *(lb./day)* equals:
- 365.25 pounds per year.—Aprx. 11/3 × 100.
- 165.7 kilograms per year.—Aprx. 1/6 × 1,000.
- 2/3 or 0.6667 ounce per hour.
- 0.4536 kilogram per day.—Aprx. 9/2 ÷ 10.
- 0.3150 gram per minute.—Aprx. 31 ÷ 100.
- 0.1826 ton (net) per year.—Aprx. 11/6 ÷ 10.
- 0.1657 metric ton per year.—Aprx. 1/6.
- 1/24 or 0.04167 pound per hour.
- 0.01890 kilogram per hour.—Aprx. 19 ÷ 1,000.

1 ounce (av.) per hour *(oz./hr.)* equals:
- 3/2 or 1.5 pounds per day.
- 0.6804 kilogram per day.—Aprx. 68 ÷ 100.
- 0.4725 gram per minute.—Aprx. 14/3 ÷ 10.

1 kilogram per day *(kg./day)* equals:
- 805.2 pounds per year.—Aprx. 800.
- 365.25 kilograms per year.—Aprx. 11/3 × 100.
- 0.6944 gram per minute.—Aprx. 7/10.
- 0.4026 ton (net) per year.—Aprx. 4/10.
- 0.36525 metric ton per year.—Aprx. 11/3 ÷ 10.
- 0.09186 pound per hour.—Aprx. 1/11.
- 1/24 or 0.04167 kilogram per hour.

1 gram per minute *(gr./min.)* equals:
- 1159.5 pounds per year.—Aprx. 7/6 × 1,000.
- 525.96 kilograms per year.—Aprx. 1/19 × 10,000.
- 60 grams per hour.
- 100/6 or 16.67 milligrams per second.
- 3.175 pounds per day.—Aprx. 32/10.
- 1.44 kilograms per day.—Aprx. 10/7.
- 0.5800 ton (net) per year.—Aprx. 4/7.
- 0.5260 metric ton per year.—Aprx. 10/19.
- 0.1323 pound per hour.—Aprx. 4/3 ÷ 10.
- 0.06 kilogram per hour.

1 ton (net) per year *(ton/yr.)* equals:
- 5.476 pounds per day.—Aprx. 11/2.
- 2.484 kilograms per day.—Aprx. 10/4.
- 1.725 grams per minute.—Aprx. 7/4.
- 0.2282 pound per hour.—Aprx. 9/4 ÷ 10.
- 0.1035 kilogram per hour.—Aprx. 31/3 ÷ 10.

1 metric ton per year *(t./yr.)* equals:
- 6.036 pounds per day.—Aprx. 6.
- 2.738 kilograms per day.—Aprx. 3/11 × 10.
- 1.901 grams per minute.—Aprx. 19/10.
- 0.2515 pound per hour.—Aprx. 1/4.
- 0.1141 kilogram per hour.—Aprx. 8/7.

1 pound (av.) per hour *(lb./hr.)* equals:
- 8766. pounds per year.—Aprx. 7/8 × 10,000.
- 3976. kilograms per year.—Aprx. 4,000.
- 10.89 kilograms per day.—Aprx. 11.
- 7.560 grams per minute.—Aprx. 3/4 × 10.
- 4.383 tons (net) per year.—Aprx. 4/9 × 10.
- 3.976 metric tons per year.—Aprx. 4.

1 kilogram per hour *(kg./hr.)* equals:
- 19,325 pounds per year.—Aprx. 19,000.
- 8,766 kilograms per year.—Aprx. 7/8 × 10,000.

1 kilogram per hour *(kg./hr.)* equals:
- 52.91 pounds per day.—Aprx. 53.
- 100/6 or 16.67 grams per minute.
- 9.663 tons (net) per year.—Aprx. 29/3 or 3/31 × 100.
- 8.766 metric tons per year.—Aprx. 7/8 × 10.

1 ounce (av.) per minute equals:
- 3¾ pounds per hour, which see for other values.

EQUIPMENT OF AN ELECTROMETALLURGICAL LABORATORY.*

BY R. S. HUTTON AND J. E. TETAVEL.

In considering the equipment of a laboratory for experimental work in electrometallurgy, the point of utmost importance should be, in the first place, to provide power to enable the experiments to be carried out on a reasonably large scale. The actual magnitude of the power equipment must be regulated by two principles. It is very desirable that the experiments, though not on a scale directly comparable with the commercial process, should nevertheless be of sufficient magnitude to furnish reliable practical data. On the other hand, as the question of cost has, unfortunately, to be considered, it is necessary to keep the equipment within certain limits, so that any given experiment can be repeated frequently under all possible conditions. Such work will supply not only valuable scientific information, but also the necessary data for practical application.

Having said thus much with regard to the scale of the work, let us consider what should be the main points governing the choice of equipment. The variety of different forms of electric furnaces which have been proposed or used is extremely great, and it would be altogether impossible to provide in any laboratory, however large or wealthy, even the most important of these. With regard to the generating plant, the same may be said. In commercial work we find conditions varying from the 15,000-volt nitric acid plant down to the 4 or 5 volts required by the zinc or aluminium processes; from the continuous current used in all electrolytic work to the polyphase alternating current employed in the purely electro-thermal reactions.

Our object, therefore, must be not to establish a limited number of definite examples, but to obtain an equipment extremely flexible, so that, without serious expense, any of the conditions required by such work may be obtained. It is, unfortunately, rarely possible to turn an ideal into a concrete fact. The development of a laboratory must necessarily be gradual, each year bringing alterations and improvements. Nevertheless a description of the actual equipment of the electrochemical laboratory of Owens College may be of some value to those interested in the subject, either from a commercial or theoretical point of view. The motive power at present available is rather insufficient, but hopes are entertained that it may before long be increased. It consists of a gas engine and motor, which can be coupled onto the same driving shaft, and together are capable of developing a net output of 30 to 40 kw. The generating plant comprises several different types of machines.

One unit of 40 kw is capable of being connected so as to give any electromotive force between 10 and 200 volts, the maximum current being 600 ampères. This dynamo is used for arc fur-

* This is one part of a paper read before the Manchester section of the (British) Institution of Electrical Engineers. Mr. R. S. Hutton, who visited this country last year and read a paper on the fusion of quartz in the electric furnace at the Niagara Falls meeting of the American Electrochemical Society (Electrochemical Industry, vol. I. p. 58), is in charge of the electrochemical laboratory of Owens College, Manchester. In the other parts of their paper the authors give notes on technical processes, mainly those used at Niagara Falls, which have already been fully discussed in ELECTROCHEMICAL INDUSTRY.—Ed.

nace work. Further, a dynamo specially intended for electrolytic work, capable of giving 1,000 ampères at 15 volts. With regard to alternating currents, a 40-kw three-phase and a 20-kw single-phase machine are provided. The latter can be connected so as to give anything between 30 ampères at 600 volts and 250 ampères at 75 volts. Finally, plant used some time ago by Mr. McDougall for the manufacture of nitric acid was presented by him to the laboratory. It will give alternating current up to 16,000 volts.

Passing now from the dynamo house to the electrochemical laboratory itself, the first problem is the exact regulation of

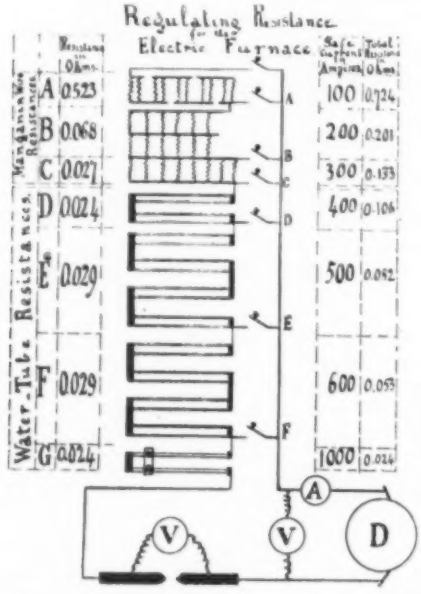


FIG. 1.—REGULATING RESISTANCE FOR ELECTRIC FURNACES.

these comparatively large currents, since, for satisfactorily studying some of the electrolytic processes, it is absolutely essential to have the current entirely under control. The diagram of the series resistance used for this purpose is shown in

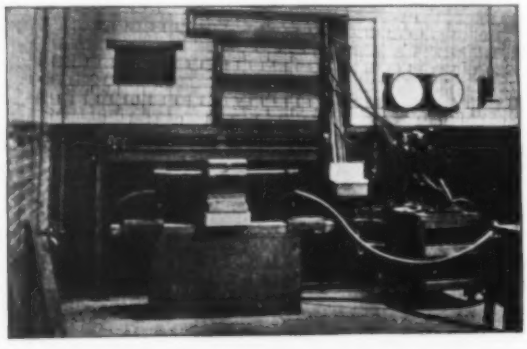


FIG. 2.—REGULATING RESISTANCE FOR 40 KW MOISSAN FURNACE.

Fig. 1. As will be seen, a number of switches are provided, by means of which successive portions may be short-circuited. Frames A, B, C are manganin wire resistances, and, together with the corresponding switches, are mounted on a stand fitted with rollers. The other frames consist of German silver tubes, fixed permanently to the wall and provided with a water circulation. D is made of ¼-inch tubes, about 4 feet long and 0.025 inch thick; E and F of ¼-inch tubes, 3 feet long and 0.03 inch thick, whilst G is of ½-inch tubes, 6½ feet long and 0.02 inch thick.

This resistance is divided into two parts, the first of manganin wire, designed particularly for starting an arc furnace, and capable of being used for currents up to 300 ampères; the second consisting of German silver tubes, water cooled, and with maximum carrying capacity of 1,000 ampères. After some consideration, the water-tube resistance was chosen as being the most suitable for regulating large currents,* and, as this subject is of some general interest, we venture to give details of the design and of the behavior under actual working conditions. The design of the water-tube frames is shown in Fig. 2, which gives a general view of the frames, and Figs. 3 and 4 give detail of the design of the terminal pieces. Fig. 2

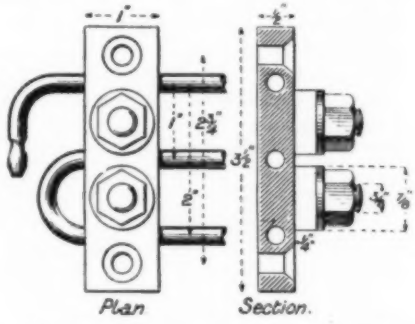


FIG. 3.—TERMINALS OF WATER-TUBE RESISTANCE (600-AMPERE FRAME).

shows the regulating resistance for a 40-kw Moissan furnace. To the right is the portable resistance, and above the 500, 600 and 1,000-ampère short-circulating switches. Bare copper strips, 1¼ x ¼ inch and 2 x ¼ inch, connect these switches with the different frames seen in the center. The two carbons are carried in massive copper holders, which can be adjusted to any given height, the leads being bolted to the vertical standard of the holder of 2¼ square inches cross section.

The frames are of two types, the first being made of parallel ¼-inch tubes for currents of 600 ampères and below. As will be seen, these tubes are let into ½ x 1-inch gun-metal strips, which are fixed onto wooden frames; each strip carries two ⅜-inch set screws, serving as terminals. One of these is used for the permanent leads, the other is useful to fix any temporary connection. The second type of frame for 1,000 ampères consists of two ½-inch German silver tubes, 6½ feet long, connected in series, and has a resistance of 0.024 ohm.

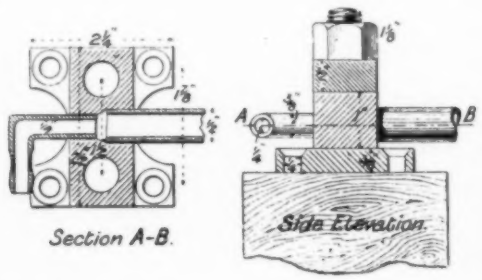


FIG. 4.—TERMINALS OF WATER-TUBE RESISTANCE (1,000-AMPERE FRAME).

The terminals shown in Fig. 4 are similar to those just described, but more massive. Two sliders are provided, of the design shown in Fig. 5, by which the actual resistance in circuit can be varied and the current adjusted with accuracy to the value desired.

As will be seen, there is a stiff central spring, by means of which the sliders are kept in contact with the tubes during adjustment. They can be clamped in any given position by two thumb screws. In considering the maximum power which

* See also *Zeitschr. für Elektrochemie*, vol. 8, p. p. 6, 58, 123, 124 (1902).

may be dissipated in a water-tube resistance, we are concerned with two principal factors. Firstly, the maximum rate at which water can be passed through the tubes; secondly, the maximum rate at which heat can be transmitted from the metal to the water. In all practical cases the first limiting factor will intervene long before the second would show its influence. The design of the water-tube frame will therefore depend on the dimensions of the tube and the available head of water. As a general guiding factor, we may say that a flow of 1 liter per minute will dissipate up to 2½ kw.

The larger tubes are distinctly the more satisfactory, since in this case there is no difficulty in obtaining an efficient flow of water from the ordinary supply. With the smaller tubes it

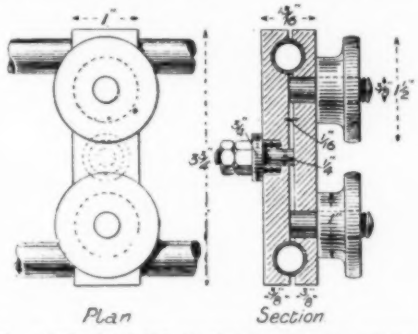


FIG. 5.—SLIDES FOR 1,000-AMPERE WATER-TUBE RESISTANCE.

is necessary to have numerous inlets and outlets, as their resistance to the flow of water is considerable.

Close to the water tubes a resistance is provided by which the exciting current of any of the dynamos can be most effectively regulated. It is in constant use for the considerable variations of voltage necessary during the progress of some of the furnace operations.

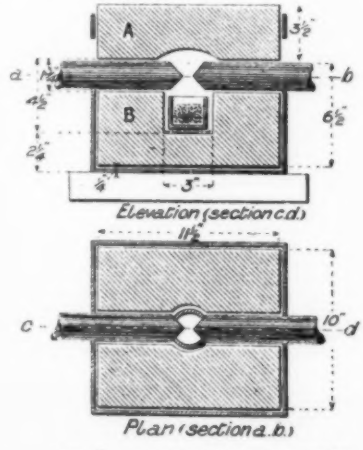


FIG. 6.—40-KW MOISSAN FURNACE.

We now come to the actual furnace equipment and the different types of apparatus which are best adapted for laboratory work. Foremost amongst these must be placed the Moissan furnace.* A dimensioned drawing of this type for a power of about 40 kw is given in Fig. 6.

This is constructed of blocks of Monk's Park bath stone, which, after trials with various limestones, has proved to be the most suitable. The furnace is composed of two blocks, the first, A, forming the cover, the second, B, the furnace proper. This latter has two grooves of slightly greater diameter than the carbons to be used. As the blocks are apt to split under the influence of the heat, they are held together by iron bands. These are provided with sockets (not shown in figure), which enable the furnace or cover to be lifted by long iron bars. The central hole, which may be of diameter 2½ to 4 inches, according to size of crucible in use, is lined at the bottom by a layer of powdered magnesia, which prevents the carbon crucible coming in direct contact with the lime. An annular space should be left around the crucible, which not only facilitates the heating, but also prevents the lime and carbon from entering into combination.

Taking into consideration the many discoveries made by Moissan in the course of his investigations, it is surprising that as yet only a very small percentage have found commercial application. The reason of this may perhaps be ascribed to the fact that this form of furnace, though proving itself eminently suitable for the pioneering work for which it was intended, scarcely gives any data on which a technical process could be founded. It is, in fact, a striking example of how the apparatus most suited for purely scientific work is seldom capable of direct commercial application. It was not until the work was taken up by the practical engineer that the scientific discovery developed into a commercial industry.

Most frequently the financial success of a process has been in direct proportion to the mechanical improvements introduced, the chemical modifications being generally of secondary importance. It is therefore necessary to be able to provide a type of

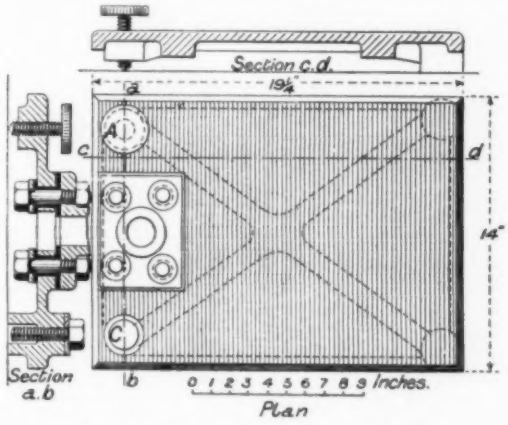


FIG. 7.—VERTICAL ELECTRIC FURNACE PLAN.

furnace corresponding in principle to the most usual technical forms, and thus carry out the experiments; if not on the same scale, at least in the same manner as would be done in the factory. Fig. 7 is a plan of an apparatus similar to that used by Haber,* which we have found extremely useful for representing many different forms of furnace. The apparatus consists of a cast-iron base, an adjustable standard and a feeding gear. The base is ½ inch ruling thickness, strengthened with rims and cross ribs 1 inch thick. At one corner a ¾-inch bolt C serves as a terminal. A is a leveling screw. The square base of the standard is insulated by a slab of vulcanized fibre, and held down by four ¾-inch bolts. See section A-B.

Fig. 8 is the vertical furnace elevation. A hollow cast-iron column R, 2½ inches diameter, is fixed onto the base shown in the previous figure, but insulated from it. The height of the gun-metal cross bar carrying the screw feeding gear can be adjusted within wide limits by means of the 1¼-inch steel rod S, which is clamped in position by the hand wheels A and B. Connection can be made at either of the terminals K or E (the latter for currents above 600 ampères), the opposite pole being connected to the base. To avoid sliding contacts, which would be objectionable for such large currents, connection from the cross bar to the screw carrying the carbon rod is made by means of four ½-inch flexibles, not shown in this figure, but which can be clearly seen in Fig. 9. The gun-metal rod T, which carries the carbon is 1½ inches diameter, with a square

* Moissan, *Le Four Electrique*, Paris, 1897.

* Haber, *Zeitschr. fur Elektrochemie*, vol. 8. pp. 1, 26, 607 (1902).

screw thread (four threads to the inch), giving a feed of about 1 foot. It is raised or lowered by means of a 7-inch cast-iron hand wheel. The design of the carbon holder is clearly shown. It is provided with rings of various diameter,

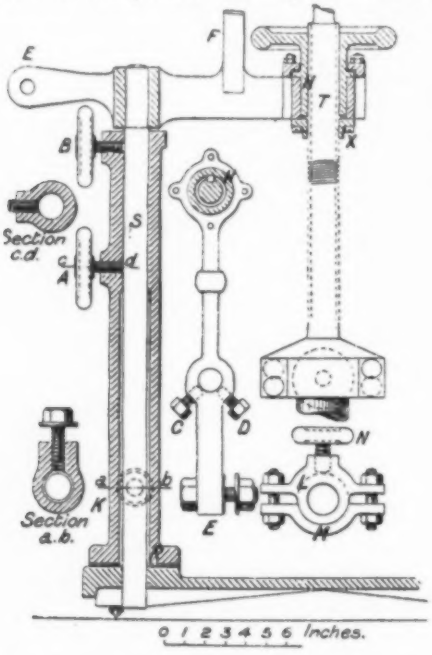


FIG. 8.—VERTICAL ELECTRIC FURNACE ELEVATION.

so that carbons of very different sizes up to 3 inches can be held.

Fig. 9, A, shows one way in which the vertical furnace, the design of which is shown in the previous figures, can be used. Upon the cast-iron base which forms the negative pole is

FIG. 9A. ELECTRIC FURNACES. FIG. 9B.

placed a large block of carbon, having a cavity which serves as a crucible. The positive electrode is formed by a carbon 3 inches in diameter, which is fed by the screw gear described above.

In Fig. 9, B, the apparatus is fitted to be used for the electrolysis of fused salts. The water jacket, by causing a layer of the fused mass to solidify, enables the electrolyte itself to form the crucible lining. This is frequently necessary, since

FIG. 10.—40 HP. CARBORUNDUM FURNACE.

with many substances it is impossible to find a furnace material capable of withstanding their corrosive action at the high

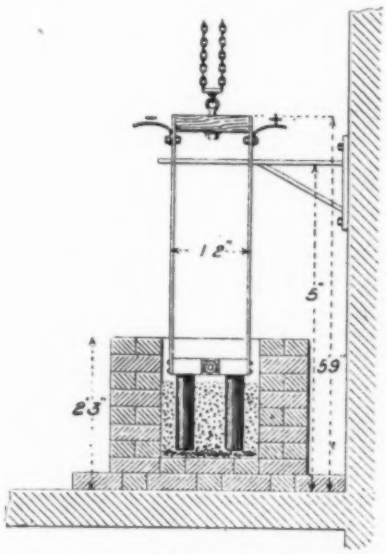


FIG. 11.—40-KW EXPERIMENTAL CARBIDE FURNACE.

temperatures which prevail. The negative pole is in this case formed by a vertical carbon, which is held in a clamp sliding on a gun-metal vertical rod fixed to the base.

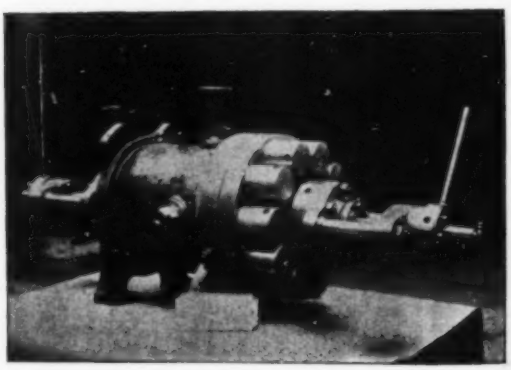


FIG. 12.—HIGH-PRESSURE APPARATUS.

Connected as shown in Fig. 9, A, the furnace has proved

itself most satisfactory for the manufacture of aluminium by the electrolysis of cryolite containing Al_2O_3. Replacing the carbon block shown in this figure by a small furnace built of loose bricks, a good example of a carbide "pot" furnace, giving a most satisfactory yield of calcium carbide, can be obtained. Frequently in the electrolysis of fused salts it is an absolute necessity to make the crucible lining of the material itself. This result is obtained (as shown by Muthmann, Hofer and Weiss)* by the use of a water-cooled crucible. The arrangement is shown in Fig. 9, B. Whilst the vertical holder enables us to represent a large number of different types of furnace, those of the Acheson carborundum type can be very simply built up by the use of ordinary materials.

Fig. 10 shows a carborundum furnace as used with 40 hp. This is an almost exact reproduction of the commercial furnace on a small scale. It is built up of loose fire bricks on a cast-iron base, the outside dimensions being 46 inches long, 28 inches broad and 21 inches high. The electrodes, consisting each of two graphite plates, 2½ x 1 inch, are in contact with coke, which also forms the core connecting the two. This is a resistance furnace of type E, shown in Fig. 13. The core is surrounded by the mixture of sand, coke, sawdust and salt, from which the carborundum is made.

The next figure (Fig. 11) is a drawing of a furnace suitable for making calcium carbide or for other furnace operations. The design is inexpensive, and the apparatus most serviceable. It represents a satisfactory and convenient laboratory form of many and important technical furnaces. The two carbons, which are clamped side by side in a single holder, but insulated one from another, are raised and lowered by means of a crane fitted to the wall. The current is led in by flat copper bars, which, by sliding in grooves, prevent any oscillation or side motion of the apparatus. The body of the furnace consists either, as shown in the figure, of fire bricks or of a large cast-iron pot. In both cases the material itself forms the actual lining.

* *Liebig's Annalen*,—vol. 320, pp. 231—269 (1902).

Such experimental equipment will be of importance not only from an educational point of view, but it is by no means impossible that certain of the difficulties in technical processes may be overcome by its use.

It is important, however, not to neglect the purely scientific work, which, though it may possibly not find any direct application in the immediate future, has, however, frequently proved to be the starting point of notable advances. In this direction the work in progress consists in the determination of the effect of gaseous pressure on high-temperature chemical phenomena. It is proposed to study carefully some of the gaseous and other reactions, which may be expected to differ considerably from those occurring under ordinary conditions.

The apparatus shown in Fig. 12 is destined for work up to 200 atmospheres and for currents up to 1,000 ampères, and has been provided out of funds received from the Government Grant Committee of the Royal Society. The apparatus is practically a steel inclosure, placed either horizontally or vertically, which can be used for any of the different types of furnace. It is air-tight, and designed for a working pressure of 200 atmospheres, being tested at 500 atmospheres. On the right and left will be seen the screw gear by which the carbons are fed, whilst in front and behind are windows which will stand the full pressure, but which can be replaced by additional connections when a circulation of gas through the apparatus is desired. The main valve, which serves also to connect the pressure gauges, will be seen on the top. The apparatus is water-jacketed throughout, the refractory material of which the furnace proper is made being contained in a cast-iron lining, thus insuring the protection of the main forging. The construction of this apparatus has been carried out by Messrs. Lennox, Reynolds and Fyfe to the designs made at the college.

ELECTROCHEMICAL LABORATORY, OWENS COLLEGE, MANCHESTER.

SCIENCE ABSTRACTS.—Our well-known contemporary, *Science Abstracts*, will in future be published in two sections: A, physics, including chemical physics and electrochemistry; B, engineering, including industrial electrochemistry.

SOLID ELECTROLYTE CELLS.

By A. L. Marsh.

Previous to the year 1885 there had not been made a voltaic cell with a solid electrolyte which, at ordinary temperatures, could generate even the smallest appreciable electric current. Sir William Thomson, now Lord Kelvin, found that when warm glass was placed between plates of zinc and copper an electromotive force was indicated by an electrometer connected with the metals. Professors Ayrton and Perry extended the observation to the cases of paraffine wax, gutta percha, india rubber and shellac. But with electrolytes of such high resistance no current could possibly be generated of sufficient strength to be indicated by the most delicate galvanometer.

On June 27, 1885, Shelford Bidwell exhibited to the Physical Society a cell with plates of silver and copper, and having for electrolyte a mixture of one part of copper sulphide (CuS) with five parts of sulphur. When connected with a reflecting galvanometer, this cell produced a current which moved the spot of light off the scale.

The electromotive force of the cell was found to be .07 volt, and the internal resistance 6,537 ohms. Upon attempting to reduce this resistance by diminishing the proportion of free sulphur, the electromotive force gradually diminished as the proportion of sulphur was decreased, until the voltage became 0, when only copper sulphide was present—at least no appreciable current was given. Copper was the positive pole of this cell.

Bidwell reasoned that the sulphur owed its efficiency to the fact that silver sulphide is formed on the silver plate by direct combination. He therefore constructed the following cell: A thin layer of copper sulphide was spread upon a copper plate and compressed into a compact mass against a surface of polished steel. A layer of silver sulphide was then spread upon the copper sulphide, and the cell was completed by pressing a plate of silver upon the silver sulphide. The current which this cell produced through the shunted galvanometer was considerably greater than that from the cell first described.

The cell was still not satisfactory. There seemed to be indications of short-circuiting, which Bidwell thought might be due to the penetration of particles of copper sulphide through the layer of silver sulphide. The silver plate was removed from the cell, and its surface brushed over with a dilute solution of sulphur in bisulphide of carbon. The plate was then heated over a gas flame, and was soon covered with a uniform and continuous layer of silver sulphide, the heating being continued until all the free sulphur was volatilized. The cell constructed with this prepared plate produced a current of 6,800 microampères through an external resistance of .2 ohm, and was able to deflect the pivoted needle of an ordinary galvanometer. The dimensions of the cell were as follows: The plates were 2 x 2½ inches; the thickness of the two layers of strongly-compressed sulphides was about one-twentieth of an inch. The electromotive force was .053 volt. The internal resistance was therefore about 7 ohms.

Carhart's "Primary Batteries" and Benjamin's "Voltaic Cell" give a brief description of the above cell. They state the electromotive force to be .5 volt, which is evidently a mistake. The correct value is .05 volt.

This cell seems to be exactly analogous to the Daniell cell.

Copper, copper sulphide, silver sulphide, silver (Bidwell cell).

Copper, copper sulphate, zinc sulphate, zinc (Daniell cell).

Bidwell adds that silver is probably the best (or only) possible metal for the positive plate.

Later Bidwell constructed a cell of lead and metallic sodium for the two plates, with lead peroxide for the electrolyte. This combination gave a very powerful current. No figures were given.

The writer undertook a brief study of solid electrolyte cells in the spring of 1900. The first experiments were a repetition of those of Shelford Bidwell with the sulphides of silver and copper, and gave results closely agreeing with those obtained by Bidwell as to the electromotive force produced in each case. The measurements were made with a reflecting galvanometer and condenser. The following combinations were then tried:

Copper, mixture of copper phosphide and red phosphorus, zinc.

Copper, mixture of copper phosphide and red phosphorus, sodium.

Copper, arsenic (metallic), sodium.

The copper phosphide was prepared by mixing pure sponge copper, obtained by electrolysis of a copper sulphate solution, with red phosphorus in the proper proportion to form the compound Cu_3P_2. The mixture was slowly heated in absence of air until combination took place, which is indicated by a slight explosion. By washing this product with a dilute solution of potassium bichromate, to which a little sulphuric acid is added, and afterward with distilled water, a procedure recommended by Boettger, a quite pure product of copper phosphide (Cu_3P_2) is obtained.

For one set of experiments, a mixture of coper phosphide and red phosphorus was taken for the electrolyte, and compressed between a piece of metallic sodium and a sheet of copper, and the whole kept under a light oil. The electromotive force was found to be about 1.5 volts, and the resistance was less than 100 ohms per square inch of contact surface. The electromotive force did not materially increase when the percentage of phosphorus in the mixture was increased to about 75 per cent., but the resistance became much greater.

By substituting zinc for the metallic sodium in the above combination, the electromotive force of the couple becomes about .8 volt. A cell prepared in a glass tube three-eighths of an inch in diameter gave a sufficiently strong current to move the mercury column of a not very delicate Lippman electrometer.

The arrangement of the cell is shown in the figure. The zinc is used in the form of an amalgam, of such a consistency that it can be poured into the cell when hot and cools to a rather solid paste. The mixture of copper phosphide and phosphorus is pressed in over the zinc amalgam, and a disk of copper is pressed firmly over the mixture. The connection to the zinc amalgam was made by a platinum wire, which was sealed into the glass. The materials used were carefully dried before putting into the cell, and the completed cell kept in a desiccator over sulphuric acid.

The following experiment was tried: A small lump of metallic arsenic was pressed against a slab of sodium, and the whole covered with a light oil. Each metal had a thin copper wire connected to it. An electromotive force of 1.2 volts was shown by a potentiometer. On another trial a copper-arsenic-sodium couple gave at the start an electromotive force of .05 volt. The cell was allowed to stand on closed circuit with 1,000 ohms external resistance. The electromotive force steadily increased, and at the end of ten days had reached .3 volt.

It is a difficult matter to get the materials absolutely free from water, but, granting that in the experiments described above there was a trace of water present, we should hardly expect the comparatively low resistance shown by solid electrolyte cells to be due to the pressure of water, since the materials are practically insoluble in water. However, the small number of experiments performed does not admit of any positive conclusions being drawn.

This class of cells has so far been but little studied, but it is to be hoped that the importance of these cells, from a scientific point of view, will induce others to take up their study. The work of the writer along this line was cut short, and facilities for its continuance are not yet available.

Owing to their rather high resistance, solid electrolyte cells will probably find little practical use. It is possible that they may be used as standards of electromotive force, but so little has been done in the study of this type of cell that their adaptability to this work is uncertain.

STEEL PRODUCTION IN THE ELECTRIC FURNACE.

Dr. Goldschmidt, the well-known inventor of the Goldschmidt process, last year received a commission from the German Patent Office to go to Italy and investigate a Stassano electric furnace which was in practical operation, in order to ascertain whether it was really possible to manufacture iron in this furnace, containing less than .2 per cent. of carbon. He had occasion, during several days, to study the process in detail, and to take samples of the raw materials and finished products for analysis. The following is an abstract from a paper about the process, read by him before a recent meeting of the Electrochemical Society of Cologne.

The plant is situated at Darfs, to the north of the dago d'Tseo. The most essential feature of the Stassano process consists in the direct reduction of the iron ores by charcoal, in combination with the heat radiated by an electric arc working above the charge. At the same time undesired compounds in the ore are slagged off by means of suitable fluxes. Large carbon rods are introduced from opposite sides into a shaft furnace, constructed of masonry, with a working chamber 1 x 1 x 1 meter, lined with magnesite bricks. They carry alternating current of about 2,000 ampères at 170 volts, and their distance from each other, which is small at the beginning of the operation, is gradually increased as the temperature rises, until the arc travels through the whole width of the furnace with a tremendous cracking and hissing noise. The electric plant is represented by two dynamos of 500 horse-power each, and one dynamo of 100 horse-power, driven by water-power.

Table No. 2 shows more exactly the working of the process in a smaller furnace, which Dr. Goldschmidt also had occasion to observe. The extraordinary purity of the iron produced by this process is due in a great measure to the purity of the Italian iron ores which were used. Suitable fluxes are added, which throw nearly all the silicon, and a considerable amount of manganese, sulphur and phosphorus, into the slag. Table No. 1 shows the composition of the charge in a case which was very closely observed, and also gives a thermo-chemical calculation of the process. Table No. 3 shows the thermic result and the calculation of the cost of production for a ton of iron under the local conditions.

TABLE NO. 1.

Composition.

Of the ore used.

$Fe_2O_3 = 93.02$ per cent.
$MnO = 0.619$ per cent.
$SiO_2 = 3.79$ per cent.
$S = 0.058$ per cent.
$P = 0.056$ per cent.
CaO, MgO $= 0.5$ per cent.
$H_2O = 1.72$ per cent.

Of the fluxes.

$CaO = 51.21$ per cent.
$MgO = 3.11$ per cent.
Al_2O_3, Fe_2O_3 $= 0.5$ per cent.
$SiO_2 = 0.9$ per cent.
$CO_2 = 43.43$ per cent.

Of the coal.

$C = 90.42$ per cent.
$Ash = 3.88$ per cent.
$H_2O = 5.70$ per cent.

Of the charge.

Ore = 100 kgs
Coal = 23 kgs
Flux = 12.5 kgs

Of the iron produced.

Fe = 99.764 per cent.
Mn = 0.092 per cent.
Si = per cent.
S = 0.059 per cent.
P = 0.009 per cent.
C = 0.090 per cent.

Of the additions.

C = 59.2 per cent.
Hydrocarbons = 40.5 per cent.
Ash = 0.27 per cent.

Of the charge per 100 kgs ore.

ore:
$Fe_2O_3 = 93.02$ kg
$MnO = 0.619$ kg
$SiO_2 = 3.79$ kg
$S = 0.058$ kg
$P = 0.056$ kg
CaO, MgO $= 0.5$ kg
$H_2O = 1.72$ kg

coal:
$C = 20.9$ kg
$Ash = 0.892$ kg
$H_2O = 1.21$ kg

fluxes:
$CaO = 6.401$ kg
$MgO = 0.389$ kg
$SiO_2 = 1.125$ kg
Al_2O_3, Fe_2O_3 $= 0.062$ kg
$CO_2 = 5.429$ kg

THERMO-CHEMISTRY OF THE PROCESS.

General.

Coal, 7,500 cal
With 20 per cent. efficiency, 1,500 cal
1 hp.-hour = 653.3 cal
With 80 per cent. efficiency, 508.24 cal
Therefore, effect of 1 kg coal = effect of 3 hp. hours.
There are used:
For the decomposition of 1 gram mol Fe_2O_3, 192.000 cal
For the conversion of 1 kg water of 100° into steam of 100°, 637.000 cal
For the heating of 1 kg steam of 100° by 1°, 0.480 cal
For the calcination of 1 kg of flux, 425.000 cal
For the heating of 1 kg mol CO_2 for 1°, 0.016 cal
For the heating of 1 gr mol Co_2 for 1°, 0.0068 cal
For the melting of 1 kg of iron, 350.000 cal
For the melting of 1 kg of slag, 600.000 cal
By the combustion of 1 kg C to CO there are generated 2,175.000 cal

Special.

There are used:
For the decomposition of the oxide of iron, $93.02 \times 192 \div 0.16 = 111{,}552.000$ cal
For the evaporation of water from ore and coal, $(1.72 + 1.21) \times 637 = 1{,}866.41$ cal
For the heating of the water vapor to 500°, $2.93 \times 0.048 \times 400 = 562.56$ cal
For the calcination of the fluxes, $12.5 \times 425 = 5{,}312.5$ cal
For the heating of the CO_2 to 500°, $5.429 \times 0.016 \times 500 \div 0.044 = 987.09$ cal
For the heating of the generated CO, $20.9 \times 0.0068 \times 500 \div 0.012 = 5{,}921.667$ cal
For the melting of the iron produced, 65×350, 22,775.2 cal
For the melting of the slag, 13.89×600, 8334.0 cal
Total, 157,311.427 cal
By the combustion of C to CO are generated, 20.9×2175, 45,457.5 cal
Difference, 111,853.927 cal

111,853.927 cal at 80 per cent. efficiency = 219.08 hp hours, or, as 65.114 kgs of iron are produced, per kilo of iron = 3.364 hp hours. One ton of iron, therefore, would cost in electric power at 0.0057 lire per hp hour = 19.17 lire or 15.34 marks, or about $3.83. Cost of one developed electric horse-power, 300 lire.

Yearly costs: 10 per cent. interest and depreciation, 30 lire; maintenance, 10 lire; total 40 lire, 32 marks, or about $8.

One hp hour costs, therefore $\frac{400}{1000} = 0.0057$ lire = 0.45 pfennig, or about 0.11 cent.

TABLE NO. 2.

Example of an operation (in the small furnace, with 1,000 ampères and 80 volts):

Charge, 70.25 kgs, ore mixture of the following composition:

Iron ore	1,000
Limestone	125
Carbon	160
Additions	120

Product obtained, 308 kgs wrought iron.

The charge contained in this operation:

46.51 kg Fe_2O_3
0.309 kg MnO
1.895 kg SiO_2
0.25 kg CaO + MgO
0.86 kg H_2O
} from ore.

3.263 kg CaO
0.194 kg MgO
0.056 kg SiO_2
0.031 kg $Al_2O_3 + Fe_2O_3$
2.714 kg CO_2
} from fluxes.

7.234 kg C
0.310 kg Ash
0.456 kg H_2O
} from coal.

3.552 kg C
2.43 kg hydrocarbons
0.016 kg ash
} additions.

Properties and quantity of the materials:

Substances	Charged gr.	Obtained gr.
Fe	32,557.29	30,727.312
Mn	239.745	28.336
Si	910.448	traces
S	29.000	15.172
P	28.000	2.772

Progress of the operation:

At 8.15 the charge commences and current is put on. At 9.15 charging is finished, and at 10.15 casting takes place. The current is regulated in such a way that, after twenty minutes, the voltage is 80 and the current 800 ampères. After a further twenty minutes 100 volts and 1,000 ampères are put on, and after thirty minutes the voltage is reduced to 70 and the current to 600 ampères. After thirty minutes more the voltage is reduced to 50 and the current to 500 ampères, and during the last twenty minutes 100 volts and 1,000 ampères are used. The total energy equals 7,290,000 volt-ampère minutes, which, at a power factor of 0.8 equals 97,200 watt hours, or 132.24 horse-power hours.

TABLE NO. 3.

Final thermic result:

	Calories.
For the reduction of the resulting Fe are necessary $30,727.312 \times 192 \div 112 =$	52,730.262
For the reduction of the Mn contained in the product are necessary $28.336 \times 94.6 \div 55 =$	48.719
For the melting of the metal, $30.8 \times 350 =$	10,780.000
For the melting of the slag, $6.3 \times 600 =$	3,780.000
For the evaporation of the water and its conversion into steam of 100°, $1.316 \times 637 =$	838.292
For the burning of the lime, $6.25 \times 475 =$	2,968.75
For the superheating of the water vapor to 500°, $1.316 \times 400 \times 0.48 =$	252.672
For the superheating of the CO_2 to 500°, $2.714 \times 500 \times 0.016 \div 0.044 =$	493.454
For the superheating of the hydrocarbons to 500°, $2.43 \times 500 \times 0.27 =$	328.05
For the superheating of the CO generated in the reduction of Fe and Mn $\left(3 \times \frac{30,727.312}{112} + \frac{28,336}{55}\right) \times 500 \times 0.0068 =$	2800.131
Total	75,020.330
Heat generated by the combination of the charged C to CO during the reduction, $9.883 \times 2,175$	21,495.525
Difference	53,524.805

Therefore, as the heat furnished $= 132.24 \times 635.3 =$ 84,012.072 calories, the thermic efficiency is 61.33 per cent.

Calculation of the cost for 1,000 kg iron in a plant of 5,000 hp, producing 30 tons of steel in twenty-four hours (about 66⅔ per cent. thermic efficiency):

	Lire.
1,600 kg ore, at 15 lire	24.00
For pulverization of the ore, at 3 lire	4.80
200 kg flux, at 5 lire	1.00
250 kg cokes, at 45 lire	11.25
For pulverization of the coke, at 2 lire	0.50
190 kg additions, at 70.0 lire	13.30
For making the mixtures, at 3.0 lire	6.75
Wear of electrodes 12 kg, at 0.30 lire	3.60
Maintenance of the furnace	12.00
Wages	6.00
Utensils	3.00
Electric power, 4,000 hp hours at 0.0057	22.80
Incidental costs	3.00
Total	112.00
Minus volatile and combustible gases obtained, 900 cub. met. at 2 ent.	18.00
Remainder, actual cost	94.00

Equal to 75.2 marks, or about $18.8

TABLE NO. 4.

Composition of iron and steels produced in the Stassano furnace directly from the ores:

C = 0.04 per cent.	C = 0.04 per cent.	C = 0.17 per cent.
Mn = 0.05 per cent.	Mn = 0.12 per cent.	Mn = 0.07 per cent.
C = 0.09 per cent.	C = 0.77 per cent.	Si = trace
Mn = 0.18 per cent.	Mn = 0.65 per cent.	P = 0.029 per cent.
Si = trace	S = 0.04 per cent.	S = 0.05 per cent.
	Chromium steel:	
	C = 1.51 per cent.	
	Mn = 0.26 per cent.	
	Cr = 1.22 per cent.	

TABLE NO. 5.

Chemical composition of Italian ores:

Magnetic.	Red Hematite.
F_3O_4, 78.400 per cent.	Fe_2O_3, 88.850 per cent.
MnO, 0.700 per cent.	MnO, 0.470 per cent.
SiO_2, 8.650 per cent.	SiO_2, 2.960 per cent.
Al_2O_3, 7.330 per cent.	Al_2O_3, 3.420 per cent.
CaO, 2.100 per cent.	CaO, 0.870 per cent.
MgO, 1.030 per cent.	S, 0.078 per cent.
S, 0.055 per cent.	P, 0.093 per cent.
P, 0.008 per cent.	Loss on ignition, 2.561 p. c.
Limonite.	**Limonite.**
Fe_2O_3, 80.930 per cent.	Fe_2O_3, 73.840 per cent.
MnO, 0.567 per cent.	MnO, 0.567 per cent.
SiO_2, 1.970 per cent.	SiO_2, 1.970 per cent.
Al_2O_3, 2.152 per cent.	Al_2O_3, 2.152 per cent.
CaO, 0.590 per cent.	CaO, 0.590 per cent.
P, 0.124 per cent.	P, 0.124 per cent.
S, 0.070 per cent.	S, 0.070 per cent.
Loss on ignition, 12.630 p. c.	Loss on ignition, 15.550 p. c.

The surprising result is gained that, by using water-power, the ton of iron can be produced for about $18.8. The item of only 3 lire for incidental costs appears, however, too small. Anyway, the result of the closely-watched experiment teaches that this method of producing iron and steel can come into consideration everywhere where cheap water-power and pure iron ores enter into the question. Besides Italy, Chile *f. e.*

comes into consideration, and the Chilean Government has sent a representative to study the process thoroughly.

Dr. Goldschmidt came to the conclusion that, for Germany, the process could not compete with the usual metallurgical method of producing steel. For crucible steel, however, the case might be different. Eventually the process might be used in such a way that ordinary pig iron were refined in the Stassano furnace. But extended experiments are still necessary to prove such a possibility.

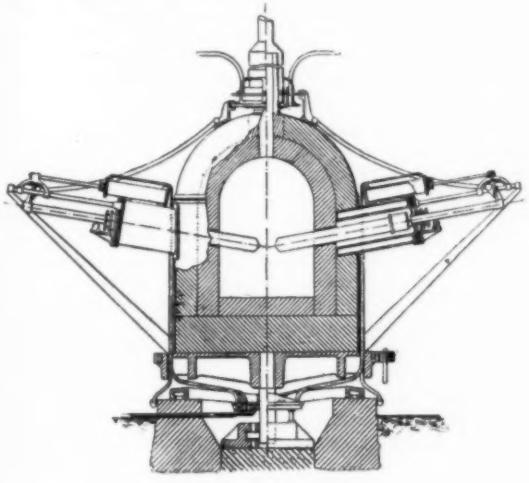


FIG. 1.—STASSANO FURNACE.

In any case, this is a method which has passed the first experimental stage, and merits serious consideration and attention. It cannot be omitted, however, to state that for the installation on a large scale a good deal of money will have to be paid yet for experience, as the Stassano works in Italy have already had about 1,000,000 lire sunk into them without having, up to this time, taken up manufacturing on a large scale. One of the drawbacks there has been that Stassano has no skilled

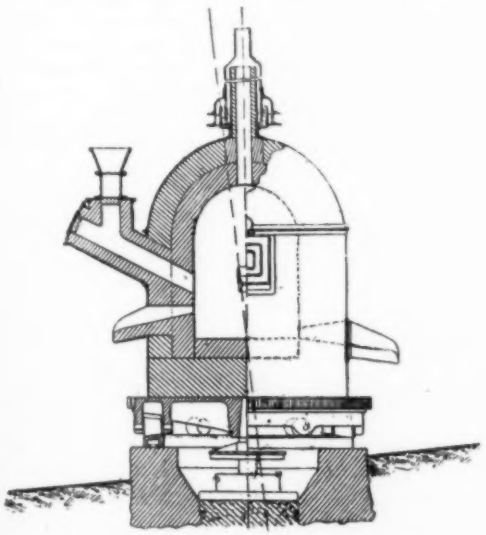


FIG. 2.—STASSANO FURNACE.

men whatever, and has to be, in fact, his own machinist, laborer, furnace man and chemist, so that he merits the greatest praise for his extraordinary zeal and tenacity in reaching the goal which he set himself.

From the above detailed figures and tables, it is pretty evident that the calculations are based upon the local conditions of Italy, and that for other countries the results of the calculations would be quite different. For this reason we have given Dr. Goldschmidt's tables and calculations in full, so that our readers are enabled to recalculate the cost of the process for different conditions.

The latest form of the Stassano furnace is shown in the accompanying illustrations. Fig. 1 is a cross section of the furnace through the plane of the electrodes, and Fig. 2 is a cross section at right angles to Fig. 1. It will be noticed that the furnace is arranged for being revolved around a vertical axis. The arrangement for drawing the electrodes apart during the operation of the furnace is also plainly visible in the figures.

SOCIETY OF ELECTROCHEMISTS AND METALLURGISTS.

The new British Society of Electrochemists was successfully inaugurated on February 4th at the general meeting held at St. Ermin's Hotel, London. After a few introductory remarks had been made by the president of the British Institution of Electrical Engineers, Mr. James Swinburne, the formal motion that the Society be formed was moved by Mr. Joseph Swan, F. R. S., and seconded by Mr. Alexander Siemens. It was stated that similar organizations for the promotion of electrochemical science and practice had been in existence for a considerable time both in Germany and the United States. The seriousness of adding to the already very great number of existing scientific societies had been keenly felt by the provisional committee, but up to the present, at any rate, owing to the peculiar nature of the sciences of electrochemistry and electrometallurgy, no satisfactory *modus vivendi* had been arrived at for affiliation with an existing organization. The following council was unanimously elected:

President, J. W. Swan; vice-presidents, Prof. A. Crum-Brown, Lord Kelvin, Sir Oliver T. Lodge, Dr. Ludwig Mond, Lord Rayleigh, Alexander Siemens and James Swinburne. Council, George Beilby, Bertram Blount, A. J. Charleton, W. R. Cooper, Sherard Cowper-Cowles, Dr. F. G. Donnan, Prof. A. K. Huntingdon, Dr. R. A. Lehfeldt, Dr. W. S. Squiere, Dr. O. J. Steinhart. The honorable secretary is F. S. Spiers, 82 Victoria street, S. W., London.

CARNEGIE INSTITUTION GRANTS.—The Carnegie Institution, through President Gilman, formerly president of Johns Hopkins University, has made five grants of money to Johns Hopkins men to assist original researches. Two of these were announced by President Remsen lately, as follows: To Dr. Harmon N. Morse, professor of analytical chemistry, $1,500 for an assistant in his researches upon the new method he has evolved for measurement of osmotic pressures. Dr. J. B. Whitehead, in the physical department, has received a liberal grant to carry forward a research in the theory of the magnetic field developed by Maxwell..

PRODUCTION OF ZINC BY ELECTRICITY.—United States Consul Bergh sends from Gothenburg the translation of an article recently published by a local newspaper on experiments made by Dr. De Laval on the production of zinc from the ore by electricity at the factory Önan, belonging to Trollhättans Elektriska Aktiebolag, Trollhättan. It is reported that the manufacture of carbide at Önan has been discontinued and the production of zinc by Dr. De Laval's method adopted. An expert states: "Dr. De Laval has for several years worked on the problem of producing zinc by electricity from lead-sulphur-zinc ores. He was probably led to this by his experiments in trying to separate iron from ores by electricity. An examining board has reported favorably on the method, and the result has been the organization of a company to exploit the invention and the ore deposits at Saxberget, near Ludvika. The minimum capital—$26,800—has already been paid, and the company will start operations as soon as circumstances will allow."

ANALYSIS OF CURRENT ELECTROCHEMICAL PATENTS.

By George P. Scholl.

Electric Furnaces and Furnace Products.

Method of Reducing Metallic Oxides. Edward G. Acheson, Niagara Falls, N. Y. Patent No. 718,891, January 20, 1903. Application filed December 4, 1900.

Electric Furnace. Edward G. Acheson, Niagara Falls, N. Y. Patent No. 718,892, January 20, 1903. Application filed December 20, 1900.

In these patents Mr. Acheson describes a method for the production of metals in an electric furnace, heated by means of a core of carbon. On account of reactions taking place between the reduced metals and the carbon of the core, with the production of carbides, it has hitherto been impossible to obtain pure metals in that way. It has been proposed to prevent the metals from coming into contact with the carbon core by means of an intervening layer of inert materials, such as clay, corundum, etc. This has been more or less unsatisfactory, on account of

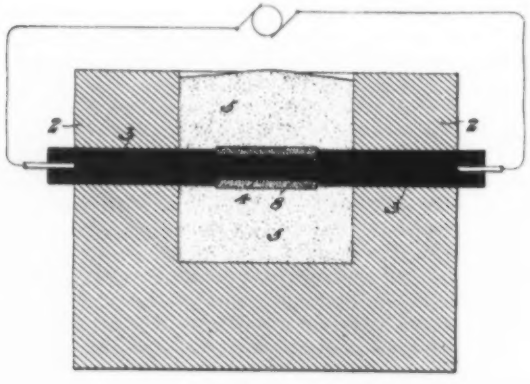


FIG. 1.—ACHESON FURNACE.

their melting at high temperatures or undergoing reactions with the core. It is now proposed by Mr. Acheson to form this intervening protecting layer out of a refractory carbide, preferably carborundum, which is stable at the highest temperatures employed for metallurgical reactions, and does not react any more with the carbon of the core. In the manufacture of substances such as silicon or boron, which form refractory carbides, a granular carbon core is simply surrounded with the material to be reduced, mixed with carbon in proper proportion to accomplish the reduction. On passing a current through the core, the material adjacent to it combines with it to form a carbide, *f. i.*, a carbide of silicon if sand has been used in the charge. This layer of carbide incloses the core and protects it from contact with the charge. The remainder of the charge is then heated by radiation, and the metal obtained from it in a fused state by the reducing action of the carbon mixed with the charge. When the conductor is not formed of carbon granules, or where it is not desired that the core should be wasted in the formation of the carbide, a layer of the oxide to be treated, mixed with carbon in proper proportion to form a carbide, is placed around the core, and the first heating action of the current converts this layer into carbide. When the material to be reduced is alumina or another material whose metal does not form a refractory carbide, either a mixture of carbon with the oxide of silicon, boron, etc., in such proportions as to form a carbide, is placed around the core, or the core is surrounded by a layer of a finely-powdered, previously-formed carbide, such as carborundum, etc. This latter procedure is preferred, on account of the property possessed by such carbides of cohering to a dense mass of good heat conductivity. The current may be either direct or alternating, and a direct current of 30 or more ampères per square inch of cross section of conductor, when the conductor is granular, and greater when the conductor is composed of rods or plates, may be employed. The operation is carried on in a furnace, shown in Fig. 1, where 2 represents the walls of the furnace, 3, 3 the terminals of the dynamo circuit, 4 the carbon core, 8 the protecting layer of carbide and 5 the body of the charge mixture. The reduced metal will collect at the bottom, and may be tapped out or removed as a pig at the end of the operation.

Electric Furnace. H. N. Potter, New Rochelle, N. Y. Patent No. 719,507, February 3, 1903. Application filed November 21, 1901. Divided and filed again November 20, 1902.

The specification describes a modification of a former patent by the same inventor, abstracted in Electrochemical Industry, January, 1903, page 187. It has the same object, namely, to provide means for preventing the current to flow unevenly in electric tube furnaces, by reason of almost unavoidable slight differences in the specific resistance of the tube, due to structural, and perhaps chemical, irregularities in the tube material. The tube is composed of a mixture of magnesia and alumina, and is provided with a number of pairs of terminals. Each pair of confronting terminals is connected to a ballast resistance, which tends to maintain an even distribution of the current from all the terminals.

Apparatus for Electro-thermally Treating Materials. Hudson Maxim, London, England. Patent No. 719,484, February 3, 1903. Application filed August 17, 1898.

The invention relates to a furnace for the manufacture of carbides. It consists of two stationary end walls, between which is situated a crucible of fire clay, mounted on wheels, which can easily be removed. Two or more pairs of electrodes enter through one of the end walls. They are made movable, and at the beginning of the operation extend through the furnace until they touch a conductor, consisting of calcium carbide in plate form, arranged on the opposite end wall of the furnace. This conductor will provide a body of highly incandescent material to start the operation of the furnace, and as the furnace charge enters into reaction between the electrodes, they are gradually withdrawn towards the other end wall of the furnace. In this way a continuing incandescent conductor is provided, and by the time the electrodes have reached the front wall, the furnace is filled with a slab of carbide. When the electrodes are drawn out entirely, the crucible is removed and the carbide allowed to cool, while another crucible, filled with fresh charge, is put into place. Means for cooling the electrodes by a series of tubes, built in the end wall of the furnace and connected with a supply of cold water, are also described.

Electric Furnace. John F. Hammond, New York, N. Y. Patent No. 720,024, February 10, 1903. Application filed February 1, 1902.

The invention relates to electric furnaces for dentists' use in continuous-gum work and other work requiring a high temperature for baking. The object of the invention is to utilize the heat to the best possible advantage, and to provide for the inspection of the work without exposing it to injurious drafts. Another object is to simplify the construction and facilitate repairs, and to provide for convenient handling of the work. A furnace embodying the above principles is described in detail.

Method of Subdividing Ingots or Blocks of Carbide. Joseph Scales, Niagara Falls, N. Y. Patent No. 719,882, February 3, 1903. Application filed May 6, 1902.

This invention consists in a method for the subdivision of blocks or ingots of such carbides which react with water, particularly for detaching large pieces of calcium carbide from ingots formed in carbide furnaces. One or more holes are drilled into the body of the ingot while it is still very hot, and at the same time water or steam is injected into the cavity, preferably through the drill. By this means the cutting surface of the drill is preserved, and the drilling operation is facilitated on account of the local disintegration of the carbide by the steam. A wedge is then driven into the drill holes and blocks of the desired size broken off.

Process of Making Tap-hole Plugs. Andrew Dickey, Niagara Falls, N. Y. Patent No. 718,828, January 20, 1903. Application filed December 2, 1901. Divided and re-filed October 31, 1902.

The invention covers the process of making such tap-hole plugs as are described by the inventor in his patent No. 714,159, abstracted in ELECTROCHEMICAL INDUSTRY, January, 1903, page 189. The plugs are designed for use in carbon-lined furnaces, and are made from compressed sawdust, paper pulp or similar material, with or without the addition of a glutinous or similar binder.

APPARATUS FOR THE ELECTROLYTIC PRODUCTION OF METALS AND COMPOUNDS.

Recovering Tin from Scrap. R. H. Gould, Surbiton, England. Patent No. 718,927, January 20, 1903. Application filed August 27, 1900.

The process consists of two stages. In the first stage the major part of the tin is removed from the tin scraps by making them the soluble anode of a galvanic cell. The electrolyte is sea water or brine, and a cathode of carbon or a mixture of carbon, with a depolarizer like pyrolusite, etc., is employed. The construction of the cell comprises a vessel, in which is placed a wicker basket, inside of which is arranged a similar basket of smaller diameter. The annular space between the wicker baskets is filled with the tin scraps, and a cylindrical carbon cathode is placed in the middle of the vessel. In some cases it is preferred to dispense with the wicker baskets and to pile the tin scraps around a number of tinned iron bars, serving as conductors and arranged in a circle around the cathode. The iron of the scraps is said to go into solution as chloride of iron, while the bulk of the tin precipitates on the cathode and part goes into solution as chlorides of tin. In order to remove the last thin layer of tin from the scraps, they are subjected to the second stage of the process, which is purely electrolytic. They are transferred to vessels similar to the above and electrolyzed by a current furnished by the cells of the first stage in an electrolyte of caustic soda. The scraps are made the anode, and a tinned iron plate serves as cathode. An elaborate example of the working of the process is given, in which vessels 6 x 6 x 6 inches served as galvanic cells, while a vessel 3 x 5¼ x 5¼ inches was used as electrolytic cell. There is nothing said about tests of installations on a practical scale.

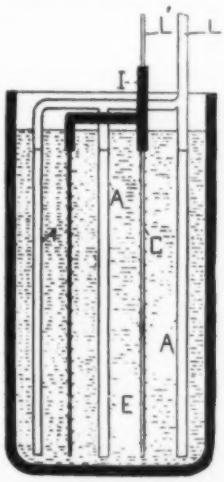


FIG. 2.—REED ELECTROLYTIC APPARATUS.

Electrolytic Apparatus. Charles J. Reed, Philadelphia, Pa. Patent No. 719,870, February 3, 1903. Application filed May 5, 1899.

The invention has for its object to improve the construction of amalgamated cathode plates, used in the deposition of highly electropositive metals, such as sodium, potassium, zinc, etc., in such a way as to retain the mercury on their surfaces and to prevent its tendency to work gradually downward. The means adopted consist in providing vertical plates of copper or other suitable metals with a number of horizontal grooves, serving as a receptacle for the mercury. The apparatus, shown in Fig. 2, consists of a glass or hard-rubber jar J, filled with an electrolyte, *f. e.*, sulphate of zinc. The anodes A may contain the metal to be operated upon, or they may consist of platinum, lead, carbon, lead peroxide, etc. The cathode C, of copper, is provided with a series of horizontal grooves, containing mercury. The metal deposited on the plate is amalgamated, as it draws the mercury out of the grooves by capillary attraction. On re-dissolving the precipitated metals, either by connecting the cathode plate with an anode of peroxide of lead or by passing a current in the opposite direction, the liberated mercury returns to the grooves. The term "electrolytic apparatus," as used in the specification, is intended to cover also storage batteries.

Electrolytic Apparatus. Charles J. Reed, Philadelphia, Pa. Patent No. 719,871, February 3, 1903. Application filed May 5, 1899.

This invention is intended to facilitate the depositing action of apparatus used for the deposition of highly electropositive metals, as sodium, potassium, cadmium or zinc, and to prevent the formation of arborescent crystals. It has been found that if such metals be deposited on an amalgam of mercury and a metal nearly as electropositive as the metal to be deposited, instead of on a plate of amalgamated copper or other highly electronegative material, that the character of the deposit is entirely changed and the growth of arborescent crystals prevented. In order to obtain the best results, it is necessary that the amalgam be in the form of an incoherent mass or paste, and for this reason a mechanical support is provided, for which purpose copper has been found well suited. The cathode of the apparatus consists of a copper plate, either wholly or partly covered with the amalgam paste. The discharge of the deposited metal takes place as above.

Electrolytic Apparatus. Charles J. Reed, Philadelphia, Pa. Patent No. 719,872, February 3, 1903. Application filed May 5, 1900.

This specification shows several constructions of cathode plates, with the same object in view as in patent No. 719,870. Receptacles of hard rubber, shown cylindrical in form, are filled with mercury, and the lower edge of the plates projects into them through a slot in the top. The plates may also be vertically divided by means of slots, and in this case a separate mercury receptacle is provided for each section. The plates may be smooth, or they may have vertical capillary grooves.

Electrolytic Apparatus. Charles J. Reed, Philadelphia, Pa. Patent No. 719,873, February 3, 1903. Application filed May 5, 1899.

This invention relates to the same subject as the preceding one, and its object is to subdivide the cathode plates into a number of divisions or panels, and to provide each panel at its lower edge with a separate receptacle for mercury, so as to insure uniform amalgamation. The frame supporting the panels is protected from electrolytic action by an insulating cover, in order to prevent a loss of mercury. A large number of different constructions are shown, having rectangular, oblong and polygonal panels, with the object of facilitating the collecting of the mercury.

Apparatus for Electroendosmotically Freeing Materials from Fluids. Botho Schwerin, Berlin, Germany. Patent No. 720,186, February 10, 1903. Application filed April 24, 1902.

This invention relates to an improved apparatus for the process of electroendosmotically freeing mineral, vegetable and animal substances from water and other fluids, covered by the inventor in patent No. 670,350. It has been found that the thickness of the layer of material subjected to the process is of great influence, and, in the case of the treatment of peat pulp, a layer above 50 centimeters in thickness entirely prevented satisfactory results. The present apparatus, therefore, provides for the subdivision of the material into a number of small layers, to be acted upon simultaneously. To this end, the apparatus is constructed of a frame work, furnished with five corrugated metal shelves, one above the other. Wooden boxes, open at the top, having a double wire netting at the bottom and filled with the material to be treated, are put upon these shelves. The netting serves as cathode, and iron plates, resting on top of the material, serve as anodes. Means are arranged by which the anodes can be simultaneously lifted, in order to remove or insert the boxes. The water, driven out from the material by the action of the current, collects in the grooved bottoms and is drawn off. It is stated that, by connecting three apparatuses, each consisting of five shelves, each shelf receiving two anodic boxes 5 cm high, 90 cm long and 80 cm wide, in series to a 225-volt dynamo, 40 to 50 per cent. of water have been removed from peat sludge in three hours, the system requiring at the beginning a direct current of about 4 ampères, decreasing to 2½ ampères at the end.

Electrolytic Diaphragm, and Process of Making Same. Hugh Rodman, Philadelphia, Pa. Patent No. 720,741, February 17, 1903. Application filed March 18, 1902.

The process of making this diaphragm consists in mixing three parts of para rubber, two parts of sulphur and fifteen parts of finely-powdered potassium sulphate, and rolling the mixture out to a sheet one-sixteenth of an inch thick. This is molded and vulcanized at a temperature of 300° F. for about ten hours, taking particular care to have this heat dry. It is then soaked in running water for four or five days, thus dissolving all potassium sulphate. The resulting product is suitable to be used in the decomposition of brine.

Process of Recovering and Separating Metals from their Ores. Hans A. Frasch, Hamilton, Canada. Patent No. 720,235, February 10, 1903. Application filed November 2, 1900.

This process is an improvement upon the inventor's former one, and is said to be particularly applicable to the treatment of copper-nickel ore and matte. The electrolytic plant proposed to carry the process into effect is illustrated in Fig. 3. Any number of baths may be aranged at progressively lower levels. Each bath has in its bottom a perforated feed pipe 7 and discharge pipe 8, and an electric conductor 9, surrounded with a quantity of coarsely-disintegrated matte 10, which forms the anode. This matte is covered with a layer 11 of sand or other chemically inert granular material. Cathode plates 12 are suspended in the upper portion of the bath. Tank 14 supplies bath 2 with brine by means of pipe 13, and bath 2 overflows into tank 15, whence the brine can be raised through pipe 16 and lifting apparatus 17 into tank 18, to be returned to bath 2. By this means circulation can be accomplished. Between each two baths is arranged an automatic regulator 19, 20, 21, 22, 36. This regulator serves to adjust the overflow of the anode and cathode solution by means of their relative specific gravity. The current decomposes the brine solution in bath 2 with the production of caustic soda at the cathodes, while a chloride solution is formed in the anode compartment by the chlorine acting upon the matte. The chloride solution leaves bath 2 through pipe 29 and regulator 19, passing through pipe 32, through the anode compartment of bath 4, etc., until, from regulator 36, it flows into tank 39. The lifting apparatus 41 delivers the metallic solution, which may have been previously acidified to increase its conductivity, from tank 39 into the cathode compartment of bath 3, the baths 3, 4, 5 and 6 having been previously filled with salt brine or metallic salt solution from previous operations. The electric current is now closed between poles 42 and 43, so that the whole series of baths is in one circuit. The least positive of the metals in the chloride solution from tank 39 is deposited on the cathodes of bath 3. The copper is precipitated in the next and the following baths, as many as are necessary to precipitate it completely. The electrolyte then flows into tank 33, where it is treated with oxidizing agents and carbonate of lime, for the purpose of removing the iron. After the removal of the iron, the electrolyte is delivered by the lifting apparatus 35, through pipe 34, into the cathode compartment of bath 6, where the nickel is deposited. The electrolyte from bath 6 flows through the cathode compartments of as many baths as are required to remove the nickel, and finally, through regulator 36, into bath 37, whence it may be returned to tank 14 and used over again for circulation. Whenever the electrolyte contains enough cobalt or metals more electropositive than nickel, the latter may be removed in the same manner as the copper and nickel in an additional number of similar baths.

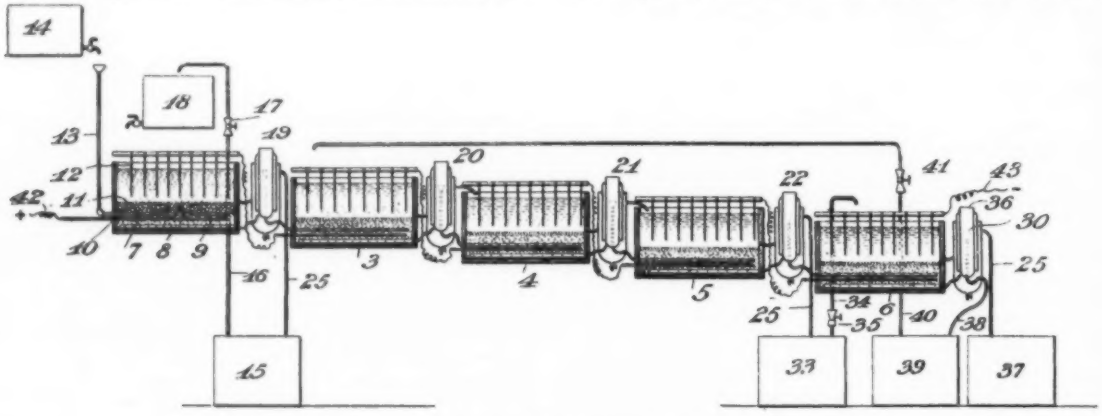


FIG. 3.—FRASCH PROCESS FOR TREATING NICKEL MATTE.

Apparatus for Decomposing Water by Electrolysis. W. F. Mason McCarty, Rockyridge, Md. Patent No. 721,068, February 17, 1903. Application filed April 22, 1902.

The apparatus consists of two tanks, connected by a pipe at about half their height. Each tank contains an electrode, which are so located that their upper ends are about in a line with the axis of the connecting pipe, through which the current passes from one tank to the other. Each of the two tanks has an outlet at the top, through which the gases generated may be led to suitable holders.

STORAGE BATTERIES.

Accumulator Plate. Wilhelm Kraushaar, Neumuehl, Germany. Patent No. 718,774, January 20, 1903. Application filed June 20, 1902.

The inventor claims "an accumulator plate consisting of a lead plate, with thin ribs or strips on both sides thereof, which are divided by cuts, characterized by the fact that the cuts which divide the ribs into several parts are opposite to a point between the cuts in the adjoining strips, and that the parts of two neighboring ribs are united by ribs of equal height similarly arranged to the cuts, with the object of increasing the effective surface and to sufficiently stiffen the electrode and at the same time decrease the weight."

Secondary Battery. Isidor Kitsee, Philadelphia, Pa. Patent No. 718,637, January 20, 1903. Application filed April 28, 1900.

The object of the invention is to produce a battery of the Faure type. It is built up of individual blocks, about 4 inches long, ¾ inch thick and 1 inch high. In order to form an electrode, the blocks can be laid upon each other with or without the interposition of a conductor. The blocks consist of a skeleton, with two face plates and three connecting lugs, consisting preferably of lead or a lead alloy. This is cast or molded, and the active material, preferably oxide of lead, is pressed into the spaces.

Electric Accumulator Plate. Auguste Bainville, Nanterre, France. Patent No. 719,418, February 3, 1903. Application filed July 14, 1902.

The improvement applies to storage batteries composed of rods, and consists in placing between the individual rods of a plate a corrugated sheet of insulating material. The sheet is perforated, so as to give the electrolyte access to the rods, and passes around adjacent rods of the same electrode in such a manner as to alternately cover half the circumference of each rod, covering the face of one rod and the back of the next. Thus the imperfection in the distribution of current between the plates, which may occur through the cylindrical shape of the rods, is for the greater part done away with.

Storage-Battery Tank. Bruce Ford, Philadelphia, Pa. Patent No. 719,778, February 3, 1903. Application filed December 11, 1902.

The objects of the invention are to provide a tank, the lining of whose compartments can be flanged all around the top of the latter, in order to prevent accumulations of acid, dust, etc., between the compartment, which would tend to produce short circuits, to provide for the draining of the acid which may find its way between the compartments and to provide a reliable, durable and efficient storage-battery tank. Each compartment is lined with an acid-resisting material, such as sheet lead or antimonial lead.

Storage Battery. Bruce Ford, Philadelphia, Pa. Patent No. 719,937, February 3, 1903. Application filed December 19, 1902.

The specification describes means for holding down wooden separators, such as are used between the plates or elements of a storage battery, and are buoyant in the electrolyte. The holder is generally oblong and provided with curved parts, so that it can be sprung into place above the separators and, by pressing upon the walls of the jar, remains in position.

Secondary Battery. F. Buchanan, Dayton, Ohio. Patent No. 720,321, February 10, 1903. Application filed March 1, 1901.

The battery is constructed of an outer circular containing cell, which constitutes the negative electrode, an adjacent circular cell constituting both positive and negative electrodes and an inner electrode constituting a positive-pole electrode. The intervening cell or electrode divides the electrolyte from the inner and outer electrodes. These electrodes are formed of lead, unmixed with alloys. The outer containing cell has a series of circular or spirally-arranged ribs on its inner surface; the second cell has such ribs on both surfaces, and the inner electrode on its outer surface. A number of recesses are thus formed, which are adapted to contain the active material.

Process of Preparing Storage-Battery Plates. R. N. Chamberlain, New York, N. Y. Patent No. 720,326, February 10, 1903. Application filed March 3, 1899.

The inventor proposes a pickling bath for storage-battery plates preparatory to forming them, which consists of a solution of 4 to 6 per cent. of nitric acid in water. The unaided action of such a solution on the lead plate would be extremely slow, but by connecting the bath in an electric circuit, so as to constitute the plate an anode, a rapid attack of the plate takes place. The lead dissolved from the plate, when it is allowed to remain in the solution, rapidly deteriorates the latter, but by the electrolytic action it is removed as fast as it is formed and deposited on a cathode, thus maintaining the efficiency of the pickling solution.

GALVANIC CELLS.

Galvanic Battery. H. Halsey, New York, N. Y. Patent No. 719,659, February 3, 1903. Application filed September 21, 1901.

The specification describes in detail a galvanic cell, the carbon element of which is in the form of a disk, and movable, while the zinc element is stationary. The idea is the same as that set forth by the inventor in patents Nos. 717,394 and 717,395, ELECTROCHEMICAL INDUSTRY, February, 1903, page 218. Complicated contact devices and rubber gearings are employed. Claim 1 reads: "In a battery the combination of a case containing a plurality of independent cells, each of which contains an excitant, a horizontally-mounted revolvable shaft and an independent rotatable element, comprising a disk vertically mounted upon said shaft and immersed in said excitant, an independent driving shaft mounted upon said case and crossing the upper ends of all said cells, independent gearing between said driving shaft and each of the revolvable elements in said cells, whereby movement of the shaft causes movement of all said elements, and means for gradually feeding a chemical depolarizing agent to the excitant solution."

Electric Battery. H. Halsey, New York, N. Y. Patent No. 719,660, February 3, 1903. Application filed April 18, 1902.

This patent covers another construction for moving one of the electrodes of a galvanic cell or the electrolyte, or both, whereby the electrodes are brushed by the electrolyte and kept clean. An electric motor, fed by current from the battery itself, is used again to furnish the power.

Electric Battery. H. Halsey, New York, N. Y. Patent No. 719,661, February 3, 1903. Application filed April 18, 1902.

The main objects of the present invention are to provide a simple means for maintaining constant motion between the electrolyte and the elements of the battery, to increase the working surface of the elements, and thus increase the capacity of the battery without increasing the rise of the battery, and, further, to avoid the necessity of swiveled connections between the conductors and the elements of the battery. A steam engine is used as motive power in this case.

Voltaic Cell. M. E. Conrad. Atlantic, Iowa. Patent No. 719,752, February 3, 1903. Application filed December 18, 1900.

The inventor says: "In the cell of my invention polarization is prevented by the conversion of the hydrogen of polarization into sulphuretted hydrogen gas. This action is most conveniently effected by using as a negative plate a sulphide of one of the metals. The nascent hydrogen, coming into contact with the sulphide, readily unites with the sulphur to form N_2S, which is immediately driven off. Of the various sul-

phides with which I have experimented (sulphides of iron, copper, lead and others), the sulphide of iron is superior in working entirely clean, giving a strong current and being cheap. In making my non-polarizing plate of a sulphide of iron, I may use native iron pyrites or a sulphide artificially made from a carbonate of oxide of iron." The best results are obtained by the use of zinc and sulphide of iron elements and dilute H_2SO_4, KOH or NaOH as the electrolyte.

Electric Battery. E. R. Gill, New York, N. Y. Patent No. 720,577, February 17, 1903. Application filed June 26, 1900.

The invention relates to an arrangement for making tests on electric circuits. A number of dry cells are arranged in a retaining block, and provision is made for quickly making connections between any two cells in the total series, thus obtaining the desired potential.

Electric Battery. M. M. Kohn, Chicago, Ill. Patent No. 720,592, February 17, 1903. Application filed July 31, 1895.

The battery belongs to the class of dry batteries having a retaining vessel made of brass, into which fits a lining of the positive electrode, zinc. The preferred electrolyte depends on the negative element employed. If it consists of copper oxide, caustic soda is used as electrolyte; in the case of carbon or peroxide of manganese, sal ammoniac is used, and in the cases of a silver compound, chloride of zinc constitutes the electrolyte. An improved construction of a carbon electrode, consisting of a series of carbon disks and depolarizer disks arranged alternately, is shown.

Electric Battery. V. G. Apple, Dayton, Ohio. Patent No. 720,653, February 17, 1903. Application filed June 3, 1901.

The patent describes a storage-battery cell, consisting of a containing cell made of lead or a lead alloy, cast, forced or otherwise formed together with a series of plates, running parallel to its side walls. The bars of which such plate is composed consist of a series of parallel strips, between which the active material is filled in. Another series of plates, joined to a connecting bar, is arranged between the first series of plates, forming the other electrode of the battery.

Miscellaneous.

Machine for Oxidizing Matrices for Electrotyping. C. M. Oliver, Baltimore, Md. Patent No. 719,053, February 3, 1903. Application filed August 26, 1902.

The object of the machine is to apply iron filings or other fine metallic particles to the face of molds or matrices and to spread and distribute them more promptly and uniformly than heretofore. The mold which is to be electrotyped, having been prepared for oxidation, is placed in a trough which can be rocked by suitable mechanism. Iron filings or other particles are shaken down on the mold from a sieve. The trough is open, and contains a liquid, and may also contain a bag of metallic salts of a character calculated to attack the iron filings, *f. i.*, sulphate of copper. When the trough is rocked, any liquid in it is swashed back and forth over the mold, carrying with it the fine particles of metal shaken down on the mold. The waves of liquid wash the particles of metals back and forth over the mold, and the chemical in the liquid acts with great efficiency on the particles.

Water Purifier. Joseph Johnson, Minneapolis, Minn. Patent No. 718,935, January 20, 1903. Application filed September 23, 1902.

The apparatus is illustrated in Fig. 4 in longitudinal section, and consists of a metal pipe 2, provided at its receiving end with a nipple 3, to which the water-supply tube is attached. The pipe is divided for a portion of its length, in order to securely fasten into it, by means of lugs 8, a cylindrical insulation of glass or porcelain. This insulator fits snugly within the pipe, and is provided on its inner surface with 2 dovetailed ribs. These ribs hold the electrodes 9 and 10 in place, and, in order to provide still more electrode surface, grooves are arranged in the ribs, and flat plates 15, 16 are respectively connected by wires 17, 18 to the electrodes. The plates, as well as the electrodes, are made preferably of copper. Air tubes 18 are also provided, in order to aerate the water. As soon as the water enters that part of the pipe between the electrodes, the circuit will be closed and the stream subjected to a current of sufficiently high potential to destroy all animal or vegetable life.

Water Purifier. E. Kaiser, New York, N. Y. Patent No. 719,471, February 3, 1903. Application filed May 8, 1902.

The apparatus described is intended to be connected with the three-wire system. The inventor's claims read: "In an apparatus, a casing provided with a bottom portion having an

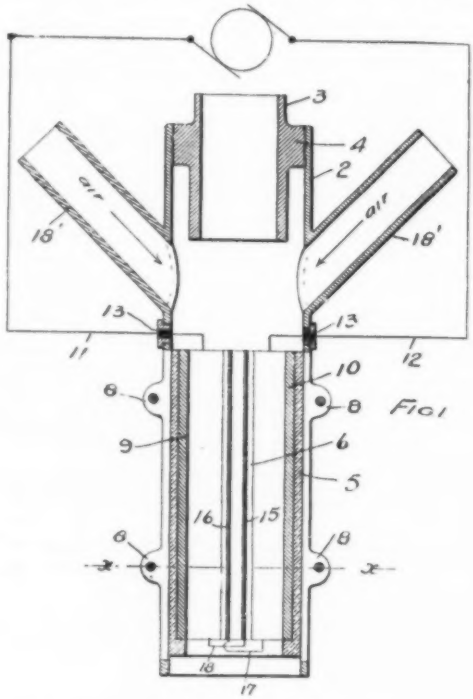


Fig. 4.—Water-purifying apparatus.

insulating cover, an insulating plate secured in said casing midway thereof and forming a bottom compartment, a plurality of spirally-arranged metal plates connected with said insulating plate and removable therewith, said spirally-arranged plates being divided into sets, the inner terminals of which are near the center of said compartment and the alternate plates of each set at their inner terminals, being in electrical connection with a binding post secured to the top of said insulating plate, and the outer ends of the other spiral plates being in connection with the casing, said casing being also provided at one side with a water supply and at the opposite side with a water-discharge pipe.

Niagara Power in Ontario.—There is a rumor that all the important municipalities within a radius of 100 miles of Toronto will co-operate in an effort to secure a Niagara Falls power concession at the approaching session of the Ontario Legislature. It is proposed to run trunk cables from Niagara Falls east as far as Toronto and west as far as London, Ont., and supply power to the different places along the routes. It is claimed that power can thus be obtained at a cost at least 50 per cent. lower than that of the present steam-produced electrical power in Toronto, which is $40 to $60 per horse-power year.

SYNOPSIS OF ARTICLES IN OTHER JOURNALS.

A Summary of Articles on Electrochemistry and Allied Subjects Appearing in American and Foreign Periodicals.

BY CARL HERING.

INDUSTRIAL ELECTROCHEMISTRY.

Dressing Ores by Means of Static Electricity.—The idea of using the repelling force of statically-charged particles for separating finely-divided ores has at last been applied in practice, and, it seems, with considerable success. The old pith-ball experiments and the dancing paper figures between two charged plates have for years been shown in schools and lectures, but although the forces are by no means very small, relatively, little or no practical use seems to have been made of them until recently. Blake and Morscher have now devised a machine based on this principle, which has been working successfully in Denver for some time. It is described, with illustrations, by SWART in the *Eng. and Min. Jour.*, January 24th. The method consists in bringing a mass of ore particles into contact with a statically-charged metallic surface. Such particles as possess relatively high conductivity are not repelled, while those of low conductivity are repelled when sufficient time has elapsed to allow them to be pulled out of their original path and caught in a separate receptacle, thus effecting a separation from the conducting material. Most of the sulphides and many of the other compounds of the valuable metals possess high conductivity, while the gangue consists largely of non-conducting material, such as quartz, lime, etc. There are exceptions on both sides; the compounds of zinc, for example, are non-conductors, thus allowing a separation to be made between pyrite, galena and chalcopyrite on the one side, and zinc blende on the other, with no preliminary roasting, dryness being the only requisite. Magnetite and pyrrhotite may also be separated from blende. A voltage of 10,000 to 20,000 is now used, the static generator being constructed almost wholly of metal, using no glass whatever, self-exciting and able to run continuously in the open air without regard to atmospheric conditions and with no more attention than an ordinary dynamo receives. The separating machines, as at present constructed, have a nominal capacity of from 12 to 15 tons per twenty-four hours, working on blende concentrates at 30 mesh. As in most methods of ore dressing, the capacity is largely governed by the mesh, coarse material passing through rapidly, while the fine goes more slowly. Their machine works well on some material at 6 mesh, and will also handle material at 200 mesh with but slight change of construction or adjustment. As in other methods, sizing improves the products, but close sizing is not essential nor even desirable. On an 8 mesh jig concentrate a sizing at or near 20 mesh will usually give the best results, coarse and fine being handled separately on the same machine, which is built double for the purpose. The standard machine is a double one, 24 feet long, 41 inches wide and 81 inches high, using about 1 horse-power, which generates the static charge and is the total power consumed. On the mixed sulphide concentrates of the Missouri-Kansas district, consisting of rosin zinc with a greater or less admixture of pyrite and galena, the machine does its best work, as far as tests have gone. But it is not confined in its operations to ores of zinc; all metallic substances, most sulphides and arsenides, and some carbonates and oxides, are thrown out of a siliceous or limy gangue, and in many instances the extraction is very high; this is particularly true of the sulphides of copper. The machine as ordinarily constructed, makes no middlings; the finely separated products contain all the material originally charged. It can be arranged in case of coarsely-crushed ores, to deliver a middlings product for recrushing when necessary. The advantages of the machine are summed up as follows: Low first cost of the machine and nominal operating expense; it separate materials without regard to their specific gravity; it works well at any mesh between 8 and 200; no roasting of sulphides is necessary; no water is required; no piece of the machine weighs 100 pounds, and any intelligent mill man or mechanic can build a machine and keep it in repair.

Commercial Cyanide of Potassium.—In an abstract of a paper read before the Chemical and Metallurgical Society of South Africa, published in the same ojurnal, February 28th, WHITBY gives the details of some tests which he made to show how the present system of purchasing cyanide for commercial use in the gold industry left the manufacturers a very wide margin for adding impurities. It is very easy for the manufacturer to comply with existing conditions, and yet supply the consumer with a lot of things he can do without. With regard to the importance of these unnecessary impurities, alkaline carbonates takes precedence over any others as tending to increase the alkalinity of solutions; then come cyanates, which are eventually changed into carbonates, and of least importance is the presence of sulphides. In his opinion it is hard to understand why so much discredit has been attached to alkaline sulphide in the cyanide. One of his samples is a cyanide so heavily charged with sulphides as to give quite a considerable precipitate with alkaline tartrate solution, and yet has been extensively used without complaint as to its effectiveness. Laboratory experiments with fresh solutions might show that sulphides are injurious, but not in working solutions containing zinc, which precipitates them as zinc sulphide. In summarizing, he says that a mixture of sodium and potassium cyanide nicely adjusted to 98 per cent. KCy and NaCy has been used, "leaving room for extensive adulteration." The effectiveness of the mixed cyanides being accepted, it would appear desirable to adopt the use of a sodium cyanide, "dropping the fiction" of calling it potassium cyanide, and demanding an efficiency of at least 50 per cent. cyanogen. Or if potassium cyanide is to be used, some limit should be given to the sodium cyanide, merely to control the amount of inactive bodies.

A New Method for Producing Pyrochemical Reactions.—Although the electric furnace can be used to great advantage for many purposes, it cannot do everything, as some people seem to suppose. It is not a mysterious something, but a well-understood tool, and like most tools it has its limitations. The same is true of the high-tension discharge, except perhaps that less is definitely known about its action. RASCH, in the *Zeit. f. Elektrochemie*, February 19th, calls attention to some of these limitations. He claims that the following requirements must be fulfilled for pyrochemical reactions in general: The ectrodes must allow a high energy density and therefore a high temperature; they must not be oxidized and they must not produce a reducing action on the reaction to be obtained. In his opinion carbon will not answer, and he suggests using for pyrochemical reactions, conductors of the second class which are chemically very persistent and stand a high temperature; for instance, rods or tubes of magnesia, aluminium oxide, etc., may be used in a similar way, as Nernst uses them in his lamp; such resistances must be pre-heated, but he does not say how. These materials may be used simply as resistances, but they may also be used as electrodes for electric discharges, but must be pre-heated. He thinks the temperatures which can be

obtained in this way are the highest which can be obtained at all.

Electrolytic Preparation of Oxygen and Hydrogen.—An illustrated description of the Schoop system of electrolyzing water is given in the *Centralblatt f. Accum.*, February 15th. The application of the pure oxygen-hydrogen flame for soldering purposes is superior to the simple hydrogen flame, as the temperature is higher. In the Schoop system the electrodes are contained in long tubes, in order to keep the oxygen and the hydrogen separate from each other; these tubes are coated on the outside with an insulating material; the length of the tubes is chosen according to the pressure under which the gases are wanted. The following results were obtained with the Schoop apparatus during one year: One electric horse-power hour gives 97.5 liters of hydrogen and 48.75 oxygen (probably under atmospheric pressure); *i. e.*, for one cubic meter of mixed gas 6.8 horse-power hours are required; with warm acid (sulphuric acid of 1.23 spec. gravity being always used) this value is reduced to 6.2 horse-power hours; if the price of one horse-power hour is 1 cent, the cost of the production of one cubic meter of mixed gases is 4.2 to 4.8 cents. The purity of the oxygen if 99 per cent., that of the hydrogen 97.5 to 98 per cent.

Duesseldorf Exposition.—In the continuations of Daniell's long serial on electrochemical and metallurgical exhibits at the Duesseldorf Exposition, he gives a review of the zinc, lead, copper, silver, nickel and cobalt mines in the districts of Germany which were represented at the exposition. Exhibits of an electrotype installation of Langbein and of copper tubes of the Elmore Copper Co., are described, also of storage batteries of various German companies and the Goldschmidt thermite process. Heraeus solders aluminium, and the soldering is said to be so perfect that the soldered pieces may be worked with the hammer and may even be rolled into sheets. This process is used for making various forms of aluminium apparatus which are said to be especially suitable for use in plants in which there is danger of the occurrence of nitric acid vapors. The largest exhibit was an aluminium basin of 1,600-liter contents, soldered together from five different pieces. Exhibits of manganese and manganese alloys (manganin) and platinum are also breifly described. The electrochemical industries of Germany alone are said to consume about 1,000 kg of platinum per year. For electrical and electrochemical purposes an alloy of 90 parts of platinum and 10 parts of iridium generally is used, because this alloy has a greater mechanical resistivity than pure platinum. Platinum sheets for electrodes are made extremely thin, down to 0.03 mm. These parts will be found in the *Zeit. f. Elektrochemie*, January 15th, 29th, February 5th and 12th.

Industrial Electrochemistry.—J. B. C. Kershaw continues his long serial on industrial electrochemistry and electrometallurgy in the *Elec. Rev.*, giving brief notes on the progress in Europe and America. The notes refer to the Elmore electrolytic copper process, the question of the calcium carbide patents and the use of electricity for glass manufacture in *Elec. Rev.*, January 24th; nickel production in Canada; new water-power centers in America, and the electric production of iron and steel, in *Elec. Rev.*, January 31st; production and use of aluminium in the United States, electric laboratory furnaces, electric chlorates, in *Elec. Rev.*, February 7th; electrogalvanizing, the works of the Ampère Electrochemical Co., electrochemical instruction in Germany, *Elec. Rev.*, February 14th; metallic sodium as a reducing agent, nitric acid and nitrates from the air, electrolytic antimony, *Elec. Rev.*, February 21st; peat-charcoal, barium and its compounds, purification of salt and brine, *Elec. Rev.*, February 28th; the efficiency of ozonizers and carbon disulphide, *Elec. Rev.*, March 7th.

Aluminium.—The *Jour. de L'Elec.*, February 15th, begins an article by Pitival on the present conditions of the metallurgy of aluminium, with special references to the article of J. W. Richards in the January number of *Electrochem. Industry*. Sperry has an illustrated article on the use of aluminium in the rubber industry for making forms, in the *Metal. Ind.* (formerly *Alumin. World*), February.

Polishing and Plating.—Hawkins continues his illustrated serial on the polishing and plating of metals in the *Am. Jeweler*, February. He discusses sewed buffs, whole buffs, cotton-flannel wheels, rouge, tripoli, crocus, white-buffing compounds, Vienna lime, sand buffing, and scratch brushes.

Magneto-Electric Machines for Electrometallurgical Purposes.—There is an interesting article in the London *Elec. Rev.*, February 20th, giving some historical notes which show that magneto-electric machines, driven by engines, had been introduced into the electrometallurgical industry at a date much earlier than is often thought. From a book published in 1844 it is quoted that Woolrich, of Birmingham, "has succeeded in applying the magneto-electric current to the reduction of metals." He used two models, a smaller and a larger, "the small machine, making 1,000 revolutions per minute, deposits 120 ounces of silver per week, and the large machine, making 650 revolutions per minute, deposits from 300 to 400 ounces of silver per week. The great expense of the production of current from voltaic batteries was clearly understood at that time.

THEORETICAL AND EXPERIMENTAL.

A New Synthesis of Hydrocyanic Acid.—A brief article by Gruszkiewicz describes an electrochemical method of making hydrocyanic acid which may be of practical value. The electric furnace is not suitable for such a synthesis, as its very high temperature has a decomposing effect upon the hydrocyanic acid formed. For such a synthesis a discharge method must be used in a similar way as in Bradley and Lovejoy's method for the fixation of atmospheric nitrogen. The production of hydrocyanic acid from acetylene and nitrogen by this method has been tried by Berthelot; there is the difficulty that acetylene is easily decomposed into carbon and hydrogen; Berthelot found that this complication may be avoided by adding to the mixture of gases a suitable quantity of hydrogen, about ten times as much as of acetylene; in this case he found that no carbon was deposited and that the reactions proceeded according to the equation

$$C_2 H_2 + N_2 = 2H C N.$$

In 160 cc of a mixture of gases, containing 10 volumes of acetylene, 14.5 nitrogen and 75.5 hydrogen, Berthelot found that after the discharges had passed the mixture for one and a half hours, 8 cc (0.01 gram) of hydrocyanic acid had been formed without any deposition of carbon. The present author repeated these experiments and found that while the deposition of carbon does not take place to any such degree as in pure acetylene, nevertheless it took place, and the two ends of the electrodes were soon short-circuited by a carbon bridge; he further found that if the gas mixture did not contain more than about 5 per cent. of acetylene (and 5 per cent. nitrogen and 90 hydrogen), there was no longer any deposition of the carbon. But he believes that this synthesis is far too expensive and complicated to be of practical value. He then experimented with a gas mixture which is cheap and easily obtainable in practice, containing carbon monoxide, nitrogen and hydrogen (water gas, Dowson gas, generator gas). He found that under proper conditions hydrocyanic acid may be obtained. The reaction would take place according to the equation

$$2 C O + 3 H_2 + N_2 = 2 H C N + 2 H_2 O,$$

but the process might also follow the following equations:

$$2 C O + 6 H_2 = 2 C H_4 + 2 H_2 O$$

$$2 C H_4 + N_2 = 2 H C N + 3 H_2$$

Both assumptions would require the same composition of the gas mixture, namely 33.34 vol. C O, 50.00 vol. H, 16.66 vol. N. But with this mixture he could not get hydrocyanic acid by passing sparks through this mixture; he found, however, that it was obtained the more C O and the less H is contained in

the mixture. The best condition for the formation of hydrocyanic acid is a percentage of 49.79 to 52.44 per cent. of C O in the mixture. In his experiments he produced the electric sparks by means of a large induction coil, the primary winding of which was supplied by six storage-battery cells. To get good results the electrodes must be very close together; if they are too far apart he did not get hydrocyanic acid, whatever the composition of his mixture was. His electrodes consisted of two thin platinum wires at a distance of 3 to 4 mm from each other. As the gas mixture used by him is easily obtainable at a low cost in practice, he thinks it is not impossible that the process has a commercial future. The complete article may be consulted in the *Zeit. f. Elektrochemie*, January 22d.

Electrolytic Superoxides.—It has hitherto always been supposed that the lead oxide deposited at the anode of a solution of a lead salt is the binoxide or peroxide of lead, PbO_2, and the weight ratio of lead to this oxide has been given as 0.866, this being the ratio of the molecular weights of Pb and PbO_2. Hollard, however, has found that 0.866 is too great and that higher oxides are deposited; also that the proportion of these higher oxides is the greater the smaller the concentration of the lead in solution. He has investigated this subject, giving a description of his researches in *Comptes Rendus*, January 26th, an abstract of which is given in the London *Elec.*, February 20th. He used platinum electrodes, the anode being platinized, and added nitrate of copper to the bath, so as to get a compact deposit of lead. The ratio Pb to the oxide was found to vary from 0.740 to 0.861 as the concentration was increased. It is most probable that very high oxides are formed, but the author has not determined their exact nature. Lead is not the only metal which shows this phenomenon, as an alkaline solution of nickel pyrophosphate yields an oxide corresponding to the formula NiO_4 and a solution of sulphate of bismuth containing a little nitric acid and copper sulphate, yields an oxide of the formula Bi_2O_5. These have been obtained only in dilute solution, as the salts are rather insoluble.

Electrolytic Preparation of Iodoform from Acetone.—ABBOTT, in the *Jour. Phys. Chem.* for February, gives an account of a series of experiments made to find the best conditions for this process. In his experiments the cathode chamber consisted of an ordinary breaker of about 500 cc capacity; in this was placed a porous cup of about 120 cc capacity, containing the anode solution of sodium carbonate, potassium iodide, acetone and water; the cathode was a cylinder of iron-wire gauze, and the cathode liquid a 10 per cent. solution of sodium carbonate, and the apparatus was maintained at a constant temperature by means of a water bath. The most favorable conditions for the preparation of iodoform by this method were found to be the following: A current density of not more than 1.35 ampère per square decimeter, a temperature of 75 deg. C., with an anode solution consisting of six grams of sodium carbonate, 10 grams of potassium iodide, 100 cc water, and 5.5 cc acetone added at the rate of 0.5 cc every 10 minutes during electrolysis; these gradual additions are necessary, as in order to keep the acetone from oxidizing and from forming condensation products, only a small quantity must be present in the anode solution at one time.

Action of Iodine on Alkalies.—In the continuation of the investigation FOERSTER and GYR on the action of halogens on alkalies, in the *Zeit. f. Elektrochemie*, January 1st, they treat more especially of the action of iodine. They determined the different steps in the processes and give the ionic equations representing the equilibria which characterize the different steps.

Reduction of Potassium Chlorate.—Bancroft (transactions Am. Electrochem. Soc., Vol. I, page 65) and Burrows had found that they could reduce potassium chlorate to chloride. BROCHET, in a brief article on "a so-called electrolytic reduction of potassium chlorate," agrees that in electrolyzing potassium chlorate with a copper anode, potassium chloride is obtained, the quantity of which is greater than should be theoritically expected, if a reaction according to the following equation be assumed:

$$KClO_3 + 3H_2 = KCl + 3H_2O$$

but he believes that the theory is entirely different. The ions K and ClO_3 act first, at the anode Cu (ClO_3) is formed, and at the cathode KOH and hydrogen; these products react with one another so that K ClO_3 is formed again together with Cu O, which is reduced by the hydrogen to metallic copper, the latter being deposited on the bottom of the cell. He believes that this deposit is a complicated mixture of CuO, metallic copper and the chloride, for he assumes that besides the above process, which he calls the "normal" reaction, there is an "abnormal" reaction according to the equation $Cu(ClO_3)_2 + 6\,Cu = Cu\,Cl_2 + 6\,Cu\,O$. The reduction of the potassium chlorate is the result of an intermediate action of the metallic copper upon the chlorate. Brochet's article is contained in the *Zeit. f. Elektrochemie*, February 19th.

Electric Analysis of Mercury.—In the *Zeit. f. Elektrochemie*, January 1st, GLASER gives an account of an experimental study on the electric analysis of mercury and the solubility of platinum in potassium cyanide. The main results are as follows: The difference observed in the electro-analysis of mercury from a potassium cyanide solution, are due to an attack of the platinum disk serving as cathode, and to the solubility of platinum in potassium cyanide. This solubility is very small at ordinary temperatures and is greatly increased when the temperature rises. The dissolving of the platinum is accelerated considerably by potassium and sodium amalgams. The solution of platinum in potassium cyanide takes place under the development of hydrogen. In a hydrogen atmosphere, gold and silver are not dissolved by potassium cyanide, even in the presence of potassium amalgam.

Antimony.—A summary of the investigations on the electrolytic preparation of antimony from its ores is given by IZART in *L'Ind. Elec.*, January 10th.

Electrons and Ions.—REINGANUM, in an article on the mechanism of electrochemistry, attempts to formulate a theory of the distribution of the electrons in the molecules entering into electrochemical reactions. He finds it necessary to assume, instead of one pair of electrons, as in Helmholtz's theory, that each molecule, say of H Cl, contains two pairs of electrons, the H atom being provided with both a positive and a negative electron, and the Cl atom likewise with one positive and one negative electron. Electrolytic "dissociation" might then be represented by the giving off of one negative electron from the H atom to the Cl atom, so that the H atom has now one positive electron, while the Cl ion has one positive electron and two negative electrons, and thus is negatively charged. When in electrolysis Cl is developed at the anode, each Cl ion gives off one negative electron and thus becomes neutral, having one positive and one negative electron. At the cathode, when hydrogen is given off, each H ion which is charged with a positive electron, receives one negative electron from the anode and thus becomes neutral, having now one positive and one negative electron. Through the external connection, the negative electrons pass from the anode to the cathode, thus completing the circuit. The author works out this idea for the different compounds and shows why the dissociation constant is a measure of chemical affinity. It is probable that the transfer of the supernumerary electron is accomplished even before actual electrolysis takes place. His article is published in the *Ann. d. Phys.*, No. 2, and is abstracted briefly in the London *Elec.*, February 13th.

Change of Volume and E. M. F. with Pressure.—When a Clark or a cadmiun cell is put under pressure, its e. m. f. is increased, because if the current is reversed through the cell a greater amount of energy is required to maintain it constant in the case when pressure is applied, than that required when

the cell is not under pressure; it was therefore to be expected that the volume of the cell was increased, or that energy was used up in overcoming pressure. Ramsey investigated this change of volume in such cells, and its relation to the change of electromotive force due to the pressure, and published the results in the *Phys. Rev.* for February. He first gives the theory of this subject and then describes his experiments. The value, calculated by him for the increase of volume for the Clark cell, is 0.11 cb mm per coulomb, and for the cadmiun cell 0.072. The values found experimentally for the Clark cell are between 0.062 and 0.232, but their mean, 0.105, is in good agreement with the calculated value. The values found experimentally for the cadmiun cell are between 0.039 and 0.054, all of which are smaller than the calculated value. He thinks this was due to a bubble of air in the cell.

Molecular Induction. A description of some curious phenomena in electrolysis is given by Gross in the *Ber. d. Deutsch. Phys. Ges.*, No. 1, 1903, an abstract of which is pubilished in the London *Elec.*, February 6th, but unfortunately this abstract, from which the present notice was taken, is not quite clear. A square glass trough is filled with a pure concentrated solution of copper sulphate, and two copper wires, reaching nearly to the bottom, enter the vessel and are connected to a high-resistance galvanometer. "A plate of zinc is suspended in the trough across the line of current and closer to one of the wires." Copper is deposited upon the zinc and a nearly constant current is observed going from the zinc plate to the more distant electrode. On moving the zinc plate towards the latter electrode, the current is reversed. He shows that each of the suppositions that would naturally be used to explain this, namely, thermal, concentration or local currents, do not apply. A high e. m. f. may be obtained by "immersing three zinc plates, insulated on one side, into the trough," and connecting the two outside ones with the galvanometer. The author maintains that there is a force not connected with chemical affinity, and, indeed, often opposed to it, which he calls molecular induction. He presupposes some effect of molecular vibrations.

Catalytic Action.—Bredig and Watson give a preliminary account in the *Zeit. f. Elektrochemie*, February 5th, of an experimental investigation of the kinetic reasons underlying the fact that a solution of potassium iodide produces a catalytic action upon hydrogen peroxide, the latter being decomposed into water and oxygen.

Electrodes Sensible to Light.—Bose found that a cell with gold electrodes in dilute sulphuric acid, which had been charged with the 110-volt lighting current, had a different e. m. f. in the dark than when illuminated, and that the oxygen electrode was the seat of the sensibility to light. Kochan has more recently made a long series of tests with this type of cell, in which he investigated the influence of light of different colors and the action of Roentgen rays, and has published the results in the *Zeit f. Elektrochemie*, January 8th, 15th and 22d.

Electrolytic Galvanometer.—In an illustrated article in the *Zeit. f. Elektrochemie*, February 5th, Heilbrun describes some experiments for demonstrating in schools or before mixed audiences that when a galvanic cell sends current through an external circuit the current flows through the electrolyte of the cell; also he says this fact is often doubted by laymen. He arranges the galvanic cell in the form of what he calls an electrolytic galvanometer by separating the anodic and cathodic liquids of the cell, placing them in two different vessels, each containing an electrode, and then connecting these two compartments by a coil, consisting of a glass tube wound in many windings and filled with the electrolyte. The magnetic action of the current flowing in this coil upon an external magnet needle can be shown, the arrangement being the same as in an ordinary galvanometer.

Thermo Cells.—As thermo cells are so frequently used in laboratories of electrochemists, particularly for analyses, on account of their convenience, the description in the *Zeit. f. Elektrochemie*, January 29th, of a new and more powerful one, by Heil, may be of interest here. He first gives a table of the thermo-electric forces of different materials. The greatest e. m. f. is obtained from constant an ($Cu_{60}Ni_{40}$ alloy) against an antimony-zinc alloy ($Sb_{100}Zn_{57}$); this he uses for his thermo cell. The antimony-zinc alloy becomes much more resistant to mechanical strains if about 3 per cent. of iron is added. He then describes special mechanical devices for getting the most favorable arrangement for heating. The efficiency of his thermo cell is 2.46 per cent., referring to the energy obtained in per cent. of the consumed energy, or 1.23 per cent. referring to the useful energy obtained in per cent. of the consumed energy. The corresponding figures for the more usual thermo cell (Guelcher) are 0.864 and 0.432. He claims that the efficiency of his thermo cell is superior to that of very small steam-driven dynamo sets.

PRIMARY AND SECONDARY BATTERIES.

The Nickel-Iron Accumulator.—It is generally the case that as soon as someone brings out something new of promising value prior inventors crop up to show that they had done it all long before. So often is this done that it almost seems as though a patent ought to be granted to the one who makes a success of a mere idea, rather than to the prior inventor, who merely makes vague suggestions by the dozen, trusting that some will afterwards be perfected by others, in which case he claims the reward. While it would probably be impracticable to make such a change in the patent law, and as such a change might sometimes do real injustice in the other direction, yet the courts, in deciding patent-litigation cases, have the power to take cognizance of such a state of affairs and deal out justice to whom it belongs.

Whether the claims in the following article are justified or not, we give them for what they are worth, as an opinion could be expressed only after a careful investigation. The original article referred to is in the *Nya Daylight Allehanda*, a Stockholm newspaper, and an abstract is given in the *Zeit. f. Elektrochemie*, February 5th. The article claims that a battery like that of Edison's was first described by the Swedish chemist, W. Jungner. In 1899 Jungner obtained a patent, claiming a battery in which potassium hydroxide is the electrolyte, and the plates consist of powdered metallic oxides, which are insoluble in the electrolyte and give a sufficient e. m. f. Before 1900 Jungner is said to have used Cd, Cu, Fe, Mn, AgO_2, Ni_2O_3 as materials. In May, 1900, a Swedish firm bought the patents, and a few months afterwards trials were made with automobiles, which are said to have given very satisfactory results. "Without exhausting the accumulators below normal voltage, the carriage, with load, is said to have run nearly 150 kw. The weight of the carriage was 528 kg; that of the battery was 290 kg. At the end of the run the carriage had still a speed of 26.5 km per hour." The nickel-silver peroxide accumulators are, however, too expensive. It is also necessary to separate the plates by asbestos, which had become useless after 120 charges, and had to be exchanged. For this reason Jungner later used nickel oxide as a positive plate and iron as a negative plate, for which combination he obtained a patent on January 21, 1901, while Edison's patent is dated February 5, 1901. The note closes with the remark that "a jury has to decide the priority."

Plates Made of Slabs of Active Material.—The conclusion of Leimer's article, the first part of which was abstracted in this synopsis last month, is given in the *Centralblatt f. Accum.*, January 15th. The current for the formation of plates of 140 x 100 x 6 mm is 1.5 ampères for the positive plate; for thinner plates, a smaller current is to be used. Thick plates are best formed with nearly constant voltage, which may be 3 to 3.2 volts at the start and about 2.8 volts at the end, so that the current decreases from 3 ampères to about

½ ampère. The result is that the core of the mass will have a crystalline, and therefore more solid, structure. The acid for forming (see the abstract last month) should be kept at 10° B. The formation should not be interrupted during the night. The ampère hours required for formation are about 35 to 45 per cent. higher than the capacity of the positive plate. For the manufacture of the negative plates, the following additional notes are given: The best composition is about three parts of minium and one part of litharge. The positive and negative plates should be formed at the same time; the latter require about twice the time of the former. The distance between the plates should be kept constant with very great accuracy, and should be equal to the thickness of the plates. After the formation, the negative plates should be kept in pure water (not in air nor in sulphuric acid). The author mentions that the positive active mass may, under certain circumstances, be a source of danger, as a few drops of glycerine on a freshly-formed positive plate cause a strong explosion after a few minutes.

GENERAL AND MISCELLANEOUS.

Optical Pyrometer.—In the proper running of electric furnaces, the measurement and regulation of the temperature may sometimes be of importance, and, as probably none of the more usual instruments for this purpose are completely satisfactory, the following one, which, from the description, seems quite simple and practicable, may be of interest. It was devised by HOLBORN and KURLBAUM, and, as the former's name is associated with the Reichsaustalt, the apparatus is probably all that is claimed for it. It is an optical pyrometer, in which the sources to be measured are compared with a standard, which is adjusted so as to appear to merge into the source to be measured. The instrument consists of a telescope, which produces an image of the source under investigation in the plane of vision; and in the same plane is mounted the loop of an incandescent filament, contained in a circular globe, which does not perceptibly influence the optical system. A red glass, tinted with cupric oxide, is inserted in the eye piece, so that a homogeneous radiation is secured. Under ordinary circumstances a simple red surface is seen through the eye pieces, and on it the black filaments. The current is then turned on, and is increased until the filament can no longer be distinguished. The filament appears to dissolve in a fiery gas, and it is impossible to locate it except by the terminals, which remain cooler, and therefore less brilliant. The photometer or pyrometer is calibrated by means of a radiating black body, as described by Lummer and Pringheim.—*Ann. d. Phys.*, No. 2; abstracted in Lond. *Elec.*, February 20th.

Acetylene Lighting for Small Cities.—An illustrated description of the acetylene central stations in Kinkau, Grieskirchen, Poechlarn and Strass, in Austria, is given in the *Zeit. f. Calciumcarbid Feb.*, February 13th and 20th.

Electrochemical Development.—A summary of the development of scientific and industrial electrochemistry during the year 1902, containing brief references to articles published and patents issued during this year, is given by KRUEGER in the *Elektrochem. Zeit.*, January, February.

CURRENT NOTES.

CONGRESSES FOR THE ST. LOUIS EXPOSITION.—The Board of Directors of the St. Louis Exposition voted, on February 10th, to organize an International Congress of Arts and Science in connection with the exposition, in accordance with the recommendations of the Administrative Board appointed in January to formulate a plan. The sum of $200,000 was set aside for the Department of Congresses. This sum will cover the expenses of the International Congress of Arts and Science and the publication of the proceedings thereof, and all other expenses connected with the promotion of other congresses and conventions. The Administrative Board of the International Congress of Arts and Science now consists of President Butler, of Columbia University; President Harper, of Chicago University; President Pritchett, of the Massachusetts Institute of Technology, Boston; President Jesse, of the University of Missouri; Mr. F. J. V. Skiff, director of the Field Columbian Museum, Chicago; Mr. Herbert Putnam, Librarian of Congress, Washington; Mr. Frederick W. Holls, New York, member of the Hague Tribunal. The appointment of Professor Simon Newcomb, of Washington, the eminent astronomer, as president of the International Congress of Arts and Science was confirmed, as was that of Professor Hugo Muensterberg, of Harvard University, and that of Professor Albion W. Small, of the University of Chicago, as vice-presidents of the congress. The president and vice-presidents were created a scientific committee to make detailed arrangements for the congress, subject to the general control of the Administrative Board and the director of congresses. The plan recommended by the Administrative Board was adopted by the directors of the Exposition, viz.:

There will be one general congress of arts and science, to begin September 19, 1904. The congress will have one definite task, namely, to bring out the unity of knowledge, and thus to bring harmony and inter-relation into the scattered scientific work of the day. Leading scholars from the whole world will be invited to discuss every theoretical and practical science in its definite position; to trace the development of each science during the last century, and to state the open problems of to-day. An honorarium and a sum for traveling expenses will be allowed to all who submit a paper in response to an invitation and who contribute a definite piece of work to the uniform plan. The plan also provides for the active participation of men of affairs. For example, the group on commerce, or on finance, or on labor, will attract business men. Groups on colonial policy, or arbitration, or municipal government, will attract politicians. The plan further provides for the participation of independent associations, national or international congresses of specialists and scientific or popular meetings.

The provision for the publication of the proceedings of the International Congress of Arts and Science, which is made in the appropriation above mentioned, will form a lasting contribution to the scientific literature of the country, and be a permanent memorial to the work of the St. Louis Exposition.

The action of the Board of Directors inaugurates the first attempt ever made at an international exposition to hold a series of related congresses, all of which should tend towards the development of one central idea. The congresses hitherto held in connection with expositions have been entirely independent, and forced to rely upon the convenience and pleasure of persons interested for their attendance. It is the first time also that a definite sum of money has been set aside to obtain the presence of men distinguished in the various fields of art, literature and science. The American Institute of Electrical Engineers is already taking steps to arrange, if possible, for an electrical congress that shall fit into the general scheme.

The official opening of the National Bureau of Standards, in Washington, will take place next summer, and numerous scientists and engineers from foreign countries are expected to attend the celebration. The date will be chosen so that, when it is over, the participants may go directly to the St. Louis Congresses.

ST. LOUIS EXPOSITION.—Prof. J. A. Holmes, chief of the Mines and Metallurgy Department, has returned, after an absence of nearly two weeks. He visited New York City, Philadelphia, South Bethlehem, Pittsburg and Raleigh, the capital of his home State. He delivered an address before the Legislature of North Carolina, and feels confident, he says, that this State will be well represented at the World's Fair. A bill carrying an appropriation of $50,000 is now pending. The interest in the Exposition has increased wonderfully since his visit East last December.

Correspondence.

POROUS DIAPHRAGMS AND CELLS.

To the Editor of Electrochemical Industry:

Sir:—In 1895, while conducting experiments having for their object the simultaneous electrodeposition of gold and mercury as an amalgam upon copper or iron cathodes from solutions of those metals in solutions containing from 0.01 to 1.00 per cent. of potassium cyanide, I used vulcanized fiber in sheets and in tubular form as diaphragms and porous cells, respectively, for the separation of the anolytes from the catholytes with apparently practical success, so far as preventing the undue mixing of the two liquids. The sheet fibre, however, buckled too much to allow even approximate preservation of such plane surfaces as are desirable for diaphragms. The tubes preserved their shape.

To close the bottom ends of the tubes, I used at first soft vulcanized "corks" or stoppers. Afterwards I used soft vulcanized rubber caps, sprung over the ends so as to compress that part of the tubes, instead of expanding them, as the stoppers did while wet..

I used tubes of various diameters and lengths up to 2 feet, and thicknesses of walls from 1-32 to ⅛ inch. Such porous cells withstand the action of weak acids and alkalies indefinitely.

I never made measurements of the specific resistances of these separators. I communicate to you the above facts, trusting that they may be of practical value to workers in electrolysis. N. S. Keith.

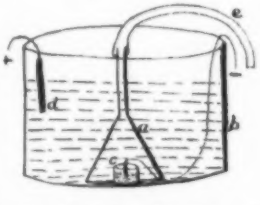
New York, N. Y., February, 1903.

THE ELECTROCHEMICAL PRODUCTION OF HYDROGEN SULPHIDE.

To the Editor of Electrochemical Industry.

Sir:—I trust it may prove of interest to some of the readers of this paper to give a short account of my experiments in electrochemistry in the line of producing this gas, sulphide of hydrogen, by the action of an electric current upon sulphur in the presence of water. The apparatus is made up as follows: A large glass dish is provided, in the center of which is placed a much smaller vessel, say a 2-oz beaker. This smaller vessel is filled with a mixture of lead filings and powdered sulphur, and is supplied with an electrode of lead connected to an insulated wire, which leads from the larger jar. Over this beaker is placed a glass funnel provided with a length of rubber tubing, and a lead or carbon plate about 3 inches square is hung from the edge of the larger vessel by means of a wire. The vessel is filled with dilute sulphuric acid.

The following rough sketch shows the apparatus:



a, the glass funnel; *b*, the large glass jar; *c*, the breaker filled with lead and sulphur; *d*, the lead or carbon plate; *e*, the rubber pipe leading from funnel.

In order to generate the hydrogen sulphide the wire leading from the small beaker is connected to the negative pole of a battery or dynamo, and a current of 3 or 4 ampères sent through the apparatus.

As the water is decomposed the hydrogen unites with the sulphur, with the result that hydrogen sulphide is thrown off, and collects in the inverted funnel, from which it passes through the rubber tube into a receiving tank or pneumatic trough provided for the purpose. The oxygen liberated at the positive pole escapes into the air.

I find this a very convenient method for the generation of hydrogen sulphide, and trust it may prove of value to some of your readers. Frank Balch.

Salem, Mass., February 26, 1903.

AMERICAN ELECTROCHEMICAL SOCIETY ELECTION.

To the Editor of Electrochemical Industry.

Sir:—It was not known until very recently that Mr. Alfred H. Cowles, Cleveland, Ohio, would consent to permitting his name to be used as a candidate for the presidency of the American Electrochemical Society, and therefore it is quite probable that among the list of those indorsed for the offices of the Society, that will be sent out by the Board of Management, his name will not appear.

As Mr. Cowles, with his brother, now deceased, was a pioneer in all commercial electric-furnace work; as the present great development in the commercial manufacture of aluminium had its beginning from the work of the Cowles Electric Smelting and Aluminium Co., at Lockport, and in Europe was an outgrowth of the agencies there set in operation by the Cowles brothers, and as he has probably done more than any other living individual to lay the foundation for the present great growth in the electric-smelting industries, we, the undersigned, think it would be doing both him and the Society a great honor to elect him to the presidency, and therefore we urge you to lend your support to this end.

We call your attention to paragraph 6 of the Constitution, to the effect that voting need not be restricted to the names of those on the lists sent out or indorsed by the Board of Directors.

Wm. O. Mathews, Marcus Ruthenburg, Geo. O. Knapp, Arvid Reuterdahl, Elmer A. Sperry, Wesley S. Block, Loren R. Vorce, John W. Langley, Edward R. Taylor, Isaiah L. Roberts, A. W. Smith, David H. Browne, Willard E. Case, Wm. R. Kenan, Jr., Chas. F. Mabery, Herbert H. Dow, W. L. Goodwin, F. O. Johnson, Perry L. Hobbs, Geo. O. Seward

Cleveland, Ohio, February, 1903.

To the Editor of Electrochemical Industry.

Sir:—A circular letter has recently been sent to the members of the American Electrochemical Society, advocating the election of Mr. Alfred H. Cowles to the presidency of the Society.

The undersigned, all residents of Niagara Falls, and members of the Society, venture to submit for consideration the following reasons in support of their belief that the interests of the Society would not be best subserved by carrying out the action proposed in the circular referred to:

1. The Society is but one year old. It is at present officered by the gentlemen whose brains conceived it, whose energy gave it birth and whose distinguished ability have made it, in its short life, a recognized factor in the scientific world. To us it seems that a failure to re-elect at this time the present executive officers of the Society would injure the bright prospects of the Society, and would show a regrettable lack of appreciation of the disinterested work done by those gentlemen during the past year.

2. In a representative body like this Society, there are included in its roll of members a considerable number of men whose commercial interests are unavoidably competitive, if not actually antagonistic. There are included in the roll members who are engaged in litigation with each other. While this need have no adverse influence on the good of the Society itself, it seems to us that the harmony, and hence the value and influence, of the Society would be best guarded by making it at least an unwritten rule that the principal office should be filled by a man who is not actively engaged in commercial life, and whose election could not be looked upon, even unjustly, as giving his business interests undue advantage over those of his fellow-members through the prestige which very properly would attach to such an honor being conferred by the Society.

3. It seems to us to be detrimental to the larger interests of the Society that at this early stage in its existence politics

should be injected into its affairs by a failure to observe that principle of dignity which is expressed by the sentiment that "the office should seek the man."

E. G. ACHESON, C. E. ACKER, F. M. BECKET, CHARLES S. BRADLEY, G. F. BRINDLEY, C. L. COLLINS, 2D; W. E. DOERFLINGER, F. A. J. FITZGERALD, A. E. GIBBS, C. M. HALL, F. W. HASKELL, F. W. HIGGINS, D. R. LOVEJOY, MAX MAURAN, C. J. PRETZFELD, A. G. RODGERS, J. C. ROBERTS, T. E. STEERE, E. S. SMITH, F. J. TONE, C. F. VAUGHN, W. M. WHITTEN.

NIAGARA FALLS, N. Y., March 3, 1903.

TO THE EDITOR OF ELECTROCHEMICAL INDUSTRY.

SIR:—The question of the nomination of a president of the American Electrochemical Society has been under discussion for a number of months past by some of those members whose only interest is the welfare of the Society. On the one hand the immediate re-election of a president was not considered a good precedent. On the other hand, as the Society is still so young it was thought to be very desirable at the present time to retain in office the chief officers like the president, secretary and treasurer for another year, as their experience during the first year would be of great value to the Society for the second year, after which it was thought the momentum of the machinery of its operation would be sufficient to make it safe to venture to turn it over to others.

After duly considering the pros and cons it was thought best to advocate the re-election of President Richards, and next year to add a clause to the constitution making a president and the vice-presidents ineligible for immediate re-election.

It can hardly be questioned that the Society would be benefited most if President Richards would serve another year. With the exception of our indefatigable secretary, there is probably no other member who has taken such a truly unselfish interest in its welfare, and who has devoted so much of his time to its affairs. As a member of the Executive Committee I can vouch for the fact that he has done a very large amount of work, not only in his position as president, but also as the chief working member of various committees. Not only is he one of the recognized leaders of his profession in this country, but he is also a cool, calm diplomat and peacemaker of rare ability, a quality which is very important in any Society which is in danger of being rent into factions. The successful launching of this Society is due largely to what he and our secretary have done for it.

The chief question was, therefore, whether he would be willing to continue to devote so much of his time to the office. This he has consented to do. I, therefore, take pleasure in recommending his re-election. As the results of the recent votes for nominations are not secret, I am not violating a trust if I say that these nominations were overwhelmingly in favor of the re-election of the present officers. The writing of this letter is due to the fact that an effort has been made to elect someone else as president. The directors did not make any official indorsement of nominations this year for evident reasons, as they would either have been forced to nominate themselves or would have to have differed with the large majority of the members.

In the present board the electrochemists engaged in the industries are not as fully represented as would seem proper and desirable, and I would therefore recommend the election as vice-presidents of such members as E. G. Acheson, C. F. Acker, A. H. Cowles (Chas. M. Hall is already a vice-president), and Col. R. M. Thompson, notwithstanding the fact that we thereby lose on the board the valuable retiring vice-presidents.

A president should, in my opinion, always be selected from the present or past officers, as he has then had an opportunity to become familiar with the management of the affairs of the Society, and has had an occasion to show whether his allegiance to it is unselfish or otherwise.

CARL HERING.

PHILADELPHIA, March 4, 1903.

Book Reviews.

MONOGRAPHIEN ÜBER ANGEWANDTE ELEKTROCHEMIE. Third volume: Die Darstellung des Chroms und seiner Verbindungen mit Hilfe des elektrischen Stromes. von Dr. Max Le Blanc, Professor of the Institute of Technology of Karlsruhe. Halle: Wilhelm Knapp. 110 pages. Price, marks 6.

The present volume is the third of the series of monographs on applied electrochemistry. It is divided into three parts, production of metallic chromium by electrolysis of watery solutions and at high temperatures, production of combinations of chromium with metals by electrolysis of water solutions and electrolysis at high temperatures, and production of combinations of chromium with non-metals. The author, who has occupied himself to a considerable extent with the electrolytic production of chromium and its compounds, has made an exhaustive study of the literature of the subject, and has collected a good deal of valuable information in this volume. The following remarks of the author, relative to the question of reproducing patent claims, will give an idea of the scope of the monograph. He says: "One can put the question on this occasion, whether it be expedient to give the contents of such phantastic specifications in a monograph. After considerable reflection, I have affirmed this question and acted accordingly. For, on the one hand, it is not always easy to draw the line between the things which ought to be incorporated and those which ought not, which is entirely an individual question; and, on the other hand, there may often be a grain of gold hidden under a mass of chaff, which might furnish a point of crystallization for later investigations or may prove to be very annoying for a later patent application. . . . The monograph, in contrast to the yearly reviews, etc., aims at a complete review of the subject under consideration, to an extent which should make unnecessary a reference to the original literature, which is sometimes not easily accessible. It wants to report everything, valuable and worthless, that has been done in the field. For these reasons I do not think a selection admissible." The reviewer is disposed to concur with the views of the author as expressed above. In times like ours, when so much is done in the different branches of science, collections like the volume under consideration are apt to be very welcome, especially to people who cannot spend all their time in following the literature. It might seem as though many of the patent claims could have been left out, but the author evidently intended to sin by commission rather than omission. On the whole, the book is a welcome addition to the literature on the subject of chromium and its compounds.

METALLURGICAL LABORATORY NOTES. By Henry M. Howe. 8vo, pp. 128. Price, $2.50. Published by the Boston Testing Laboratories, 1902.

The distinguished professor of metallurgy at Columbia University, known to the whole metallurgical world for his work in iron and steel, sets forth in these notes the guides to experimental work which he has evolved for the use of his students.

There are six groups of experiments, the first being a set of ten miscellaneous ones for those students taking a short course in metallurgy and who work in squads; the second set are ten tests in pyrometry and calorimetry; the third set are sixteen on the melting points of silicates and slags; the fourth set are nine on the properties of refractory materials; the fifth set are twenty-four on iron and steel, including five tests of microstructure; the sixth set are twenty-two tests concerning other metals than iron.

The idea which has guided the selection of the experiments has been to choose such as make the student familiar with the handling of an instrument of use to the metallurgist, and at the same time illustrate, by the results obtained, some specific metallurgical principle. Professor Howe calls this the analytical system of teaching, and holds that this gives the student

the needed equipment as an investigator of the conditions of manufacture and the qualities of product in such a way as can rarely be obtained in an actual industrial establishment. To this end, the experiments cover the use of pyrometers, the fusibility of slags as affected by composition, the properties of steel as affected by different heat treatment, the study of chloridizing roasting, electrolysis of copper, roasting of copper ore, desilverizing of lead by zinc, study of some cooling curves of alloys and their microscopic appearance and many other experiments, all useful and all instructive.

Not only will the student find here the most careful directions for metallurgical investigations, but anyone wishing to do experimental work of this nature for himself will find the book extremely useful. Electrochemists have frequently to conduct experiments involving the use of the same or of similar apparatus and methods, and they will find in the numerous directions and hints or suggestions much which will assist them in their experimental work. The various types of gas and electric furnaces used in the experiments, many devised by or for the author, will interest anyone doing experimental furnace work.

On the whole, we congratulate Professor Howe on the direction which his metallurgical work has taken. The university should not attempt to give the student that experience in actual practice which he can only properly obtain in the works, but it should train the man to observe, think, try and test, and so cultivate his higher faculties in a way which the industrial establishment does not do. Train the student in Professor Howe's way, and his mental alertness will, on leaving college, make up for any slight deficiency in practical experience, which latter he is in the best condition to learn quickly. The university is a place to train a man's brains, not his muscles, and the sight of a student in overalls wrestling with a refractory tap hole to miniature blast furnace in the basement of a laboratory inside the college grounds is a travesty on college education. Such is neither flesh nor fowl, *neither education nor real, practical experience;* it is largely a waste of valuable time and effort.

The teaching of metallurgy in our American universities and colleges will be greatly improved by the adoption of the methods advocated by Professor Howe, and already followed in a few of our technical schools, and we greet his book as an influential factor in that coming improvement.

Einrichtungen von Elektrolytischen Laboratorien, unter besonderer Berücksichtigung der Bedürfnisse für die Hüttenpraxis. By H. Nissenson. 8vo, pp. 51; figs., 32. Price, 3 marks. Wilhelm Knapp, Halle, 1903.

This brochure forms Volume IV of the monographs of applied electrochemistry. The author is director of the laboratory of a large metallurgical firm, and writes with a particular view to the requirements of metallurgical practice.

Ten pages are given up to a very condensed statement of fundamental electrolytic laws and general observations on batteries, conductors, measuring instruments, balances, tables and space requirements. The rest of the work describes in detail the arrangements in the laboratories for instruction at Aachen, Breslau, Clausthal, Darmstadt, Freiberg, Giessen, Konigsberg, Leoben, Munich, Philadelphia (University of Pennsylvania) and at the works-laboratories of Dumon Frères at Lüttich, the desilverization works at Hoboken, near Antwerp, and at the lead works at Stolberg, Rheinland.

The information here given is such that should certainly not be overlooked by anyone who has the problem of arranging for experimental work in electrochemistry. Numerous drawings and photographs show exactly how these successful laboratories are arranged, and the accumulated thought and experience in this line contained in this small and inexpensive book are a welcome addition to electrochemical literature.

ELECTRICAL MACHINERY FOR OPERATING GOLD DREDGES IN THE KLONDIKE REGION.

Electrical engineers are doing pioneer work for the electrochemists and electrometallurgists. The development is that electricity is first introduced for lighting and power purposes in a metallurgical plant. When electric current is then available, the trial and introduction of electrochemical methods is only a question of time, while also depending, of course, upon the progressiveness of the managers of the plant. For this reason electrochemists should be interested in the rapidly-increasing introduction of electrical machinery in metallurgical districts.

The Western Engineering and Construction Co., San Francisco, Cal., are about to install in the territory south of the Yukon district, a power-transmission plant for the operation of a gold dredge, which will be erected at Atlin, B. C., 2 miles distant from the power plant. This is a new development in the methods of mining in this region, which is a very important placer district; and much gold that would otherwise be lost will be saved by the use of electrically-operated dredges. The work to be done here is similar to that carried on at Oroville, Cal., although the gold is coarser in the Atlin district, being found in nuggets from the size of a pin head to that of an ostrich egg.

The electrical equipment for this plant consists of the following apparatus, recently purchased from the Westinghouse Electric and Mfg. Co.: Two 180-kilowatt belted alternators, which are to be driven by water wheels; two type F variable-speed induction motors, with controllers; two standard type C induction motors for driving the pump, one of 20 horse-power and the other of 50 horse-power, and a 15 horse-power, type C motor for operating screens.

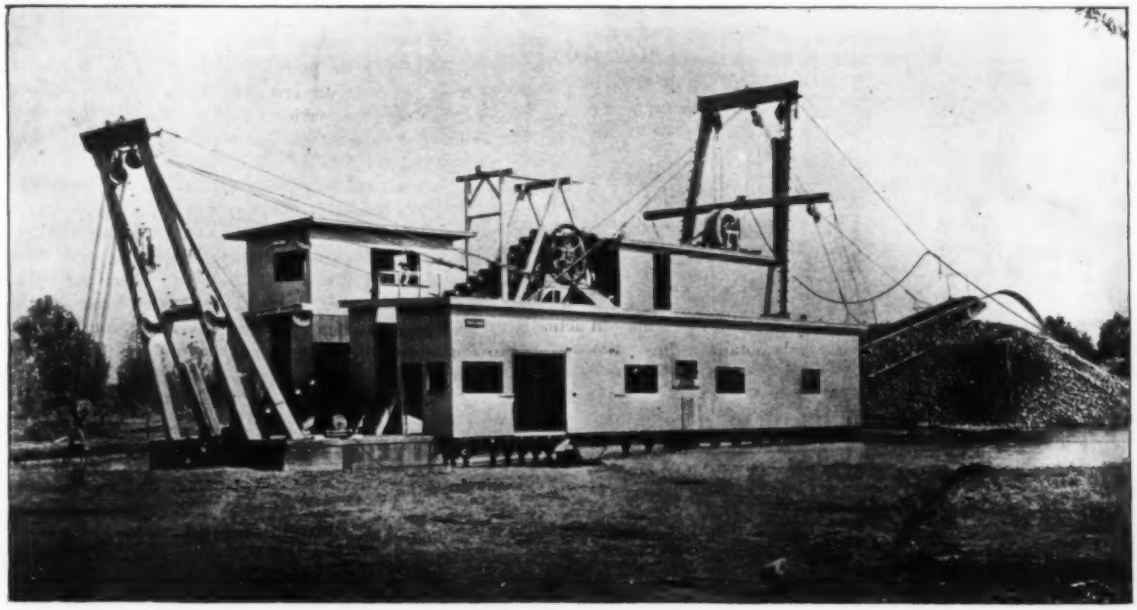
It is interesting to follow the route over which this machinery will pass before reaching its destination at Atlin. From the East Pittsburg works of the Westinghouse Co. the apparatus will be shipped directly across the continent to Vancouver, B. C., from which city it will be reshipped by steamer to Skagway. It will then be conveyed over the Chilkoot Pass to Caribou, by way of the White Horse Railway; carried by teams to Tagish Lake, where it will be reloaded on a small lake steamer and taken to a landing on the other side of the lake; then transported on a narrow-gauge road about 6 miles to another lake; reloaded on another steamer to be taken across this lake, and then freighted to Atlin.

Although all of this work has to be done in a very short season, owing to the severity of the climate, it is expected that the machinery will be in operation in July of this year, and enough gold recovered during the season to pay the entire cost of the installation, which, including the hydraulic machinery, amounts to over $150,000.

A gold dredge costs from $40,000 to $75,000, depending upon its capacity, and consists of the dredging machine proper and the pumping apparatus which supplies the necessary water for washing and sluicing. The dredge machinery comprises a chain of electrically-driven buckets, which pick up the material; a steel hopper, into which the material is emptied; a revolving screen, designed to receive and wash the excavated material; an appliance for carrying off all the coarse tailings and stones that are rejected by the screens, a sluice box, in which the water and fine material containing the gold are disposed of and in which the gold is saved. The stone chute is of a sufficient height and inclination to discharge the material clear of one side of the boat, so that no obstruction can take place on account of the accumulations of tailings. From the under side of the screen all the fine material, including the gold, is discharged with a considerable quantity of water—all of which is carried off and and over the stem of the dredge through a sluice box containing a series of riffles in which the gold is caught, and of a length sufficient to carry the tailings clear of the dredge and to save all the gold. When the gold is of too fine a character to be efficiently collected in the ordi-

nary sluice box, a finer screen and gold-saving tables are employed.

Formerly the dredging apparatus and pumps were operated by steam engines, and this practice is still largely continued. Electric power, however, is preferable, since it admits of the operation of dredges where fuel is difficult to obtain, the lighting of the dredge by electricity and, if necessary, the carrying on of the work at night. An electrically-operated dredge is illustrated in the adjoining figure, showing at the left groups of incandescent lamps mounted in reflectors.



ELECTRIC GOLD DREDGE.

ELECTROGALVANIZING.

Zinc as a protective coating for iron, after a trial of over fifty years, has proved itself to be cheaper and more effective than painting. Iron coated with zinc is called in the trade "galvanized iron" in order to characterize the nature of the protection. Whenever "galvanic" or electrochemical action is set up by the contact of iron and zinc in the presence of moisture it is the zinc which is attacked and not the iron. If the zinc coating is applied by electrolytic deposition, the process is called a cold or electrogalvanizing process to distinguish it from the hot process in which an article is coated with zinc by dropping it in a molten bath of zinc. In the following article we give a description of the electrogalvanizing process of the Cowper-Coles Galvanizing Syndicate, London.

The first care in electroplating is to have a properly prepared surface; all traces of grease and rust must be removed. Machined work, which is usually very greasy, should be immersed for about half an hour before pickling in a hot solution of caustic soda, containing about 2 pounds to the gallon of water; the work should then be placed in a hot pickle containing about 1 per cent. of commercial sulphuric acid.

The removal of mill scale from forgings and plates has always been a matter of considerable difficulty, the scale in many cases being about $\frac{1}{8}$ inch in thickness, and strongly adherent. One method is to place the iron in a solution containing one part of hydrochloric or sulphuric acid to 10 parts of water for a period varying from one-half an hour to twenty-four hours. The British Admiralty specify that all steel steam pipes, boiler and collector tubes, and all plates for boilers are to be pickled in a liquid consisting of 19 parts of water and one of hydrochloric acid until the black oxide or scale formed during the manufacture is completely removed. Plates should be placed in the bath on edge and not laid flat. When taken out of this dilute acid all the surfaces are to be well brushed and washed to clean off the loose scale. They should then be placed in a bath, filled and kept supplied with fresh water, and then be placed on end to dry.

During the process of pickling large quantities of magnetic oxide and scales become detached from the plates, which, if allowed to remain in the pickle to be further acted on by the acid, form a serious source of loss. To reduce this loss to a minimum, Mr. Sherard Cowper-Coles has devised a magnetic-scale collector, which is shown in the adjoining figure.

The figure represents a sectional cut of a lead-lined pickling tank, with a scale collector placed in position. The scale collector is connected to the electric supply mains, the current required to work it being about 10 ampères when an e. m. f. of 6 volts is employed. In the case of large baths two or more collectors may be used, or if only one is available it may be moved about to different parts of the bath at suitable intervals. From time to time the scale collector is taken out, and the adherent scale removed either by breaking the circuit or by means of a suitable brush or scraper. The apparatus is attached without any difficulty to any ordinary lead-lined pickling vat, and does not require skilled labor to look after it. All the magnetic oxide or scale on the plate is collected almost as soon as it leaves the iron or steel, instead of being allowed to remain in the solution and be acted on by the acid. A large saving of acid is thereby effected.

In this country an electrical-pickling process has been tried, the solution used being sulphate of soda or sulphuric acid. The plates to be cleansed form the negative electrode, and an iron plate the positive electrode; the oxides on the surface are reduced, and any grease that may be present is decomposed. Another method is to use the plates to be cleaned as the positive pole of a galvanic cell, the negative pole being either carbon or wire gauze electroplated with silver and covered with amorphous platinum black, the electrolyte being sulphuric acid at the negative pole and a depolarizer such as nitric or chromic acid being used at the positive pole, so that the evolution of offensive odors is avoided.

Sand blasting is often used instead of pickling, and for many purposes it is found to give better results, especially for cast-

iron work, from which it is very difficult to remove the last traces of acid. The process consists of projecting a stream of sand or other abrasive powder at considerable velocity against the surface to be treated. For cleaning iron work compressed air is generally used at a pressure of about 10 pounds per square inch, soft rubber tubes being used for conveying the sand and air to the nozzles, which are of cast steel. The nozzles are quickly worn away, but they are easily renewed at a small cost. The cost of sand blasting per square foot, under the most favorable conditions, including the cost of labor, sand and power, is one-twentieth of a cent, but the actual cost

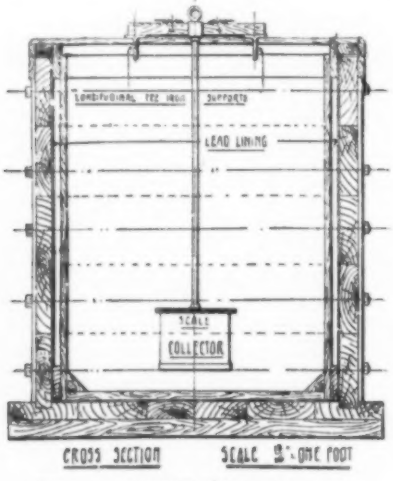


FIG. 1.—MAGNETIC SCALE COLLECTOR.

varies considerably with the nature of work. When using quartz sand of the best quality the loss is about 10 per cent. each time it is passed through the machine; the loss when using chilled-iron sand is very small, the waste of material replacing more than nine-tenths of the apparent loss.

The adjoining figures 2 and 3 show the most recent type of sand-blast equipment, as installed by the Cowper-Coles Galvanizing Syndicate for cleaning castings, plates, etc. A is an air compressor; B, compressed-air pipe; C, compressed-air reservoir; D, air valve; E, sand jet; F, sand-blast room; G, perforated grating; H, sand hopper; I, sand-section pipe; J, air-

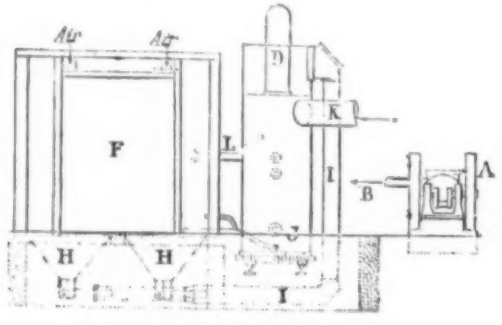


FIG. 2.—SAND-BLAST EQUIPMENT.

washing apparatus; K, inlet pipe, and L, levers for working air or sand valves.

The apparatus shown in the figures is a special one, and is combined with a dust and sand separator and sand elevator. The elevating process is effected by a current of air set in motion by an ordinary exhaust fan. The air washer J is required, if it is desired, to prevent the dust escaping with the exhaust air. This provides for the automatic return of the sand to the sand-blast apparatus in the following manner: The sand, after use, falls through the cast-iron grating into the sheet-iron hoppers underneath, and is drawn by the current of air into the main pipe leading into the apparatus. The air to take the place of that exhausted enters through the roof of the room, this prevents the dust from rising. One separator only is required by this system. The size of the sand-blast plant and room is, of course, determined by the size and quantity of the work to be operated upon.

The surface to be galvanized having thus been freed from grease and otherwise cleaned, the article is ready for the zincing bath.

The process of Mr. Cowper-Coles differs from those mostly used in this country, because in the former insoluble anodes are used. He believes zinc anodes are not suitable because, whether cast, rolled, amalgamated, or in the form of granulated zinc, they fail to keep the solution up to its normal strength. As the solution therefore must be regenerated he discards zinc altogether and uses lead anodes.

The electrolyte used in the Cowper-Coles process is constituted as follows:

Zinc sulphate ($Zn\,SO_4, 7H_2O$)	35 ounces
Sulphuric acid (specific gravity 1.84)	0.1 ounce
Water	1 gallon

To obtain good, bright deposits of zinc the solution should be kept as free as possible from impurities. When the articles to be zinced are first placed in the bath it is found advantageous to use as high a current density as possible, and after a few minutes to reduce it to about 15 ampères per square foot.

For regenerating the solution the addition of zinc oxide has

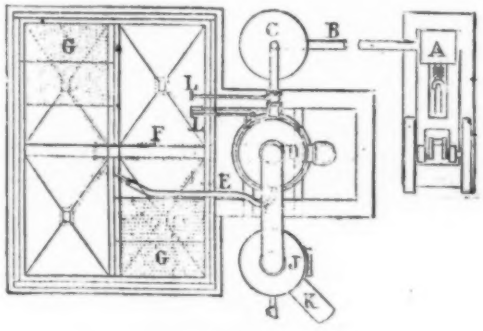


FIG. 3.—SAND-BLAST EQUIPMENT.

been suggested, but the cost is found to be too great. Mr. Cowper-Coles has found the additions of zinc dust to the electrolyte to be the only practical method of accomplishing this end. The zinc dust, which contains about 75 per cent. of metallic zinc, and usually a trace of cadmium, is cheaper in the first cost than virgin spelter. The use of it also considerably reduces the waste of zinc, as practically the whole of it is consumed. Zinc dust or tultz is a grayish amorphous substance, and must not be confused with zinc oxide. It is obtained as a sublimal product in the flues of zinc-smelting furnaces. Small quantities of zinc dust are placed from time to time in the regenerating tanks, which are connected to the depositing vats by a system of piping. The electrolyte flows into the bottom of the depositing tanks by gravity, the lighter liquid being drawn off over a sill at the end or in a corner of the vat. It is advantageous to mix the zinc dust with sand or coke and thus form a filter bed, because if the zinc dust is allowed to get into the electrolyte it is found to increase the electrical resistance.

American Institute of Electrical Engineers.—In our last issue it was stated that the annual meeting of the American Institute of Electrical Engineers would be held in June, at Niagara Falls. We now understand that this has been found to be impracticable, as no hotel is available at that time. There is still a possibility that a joint meeting with the American Electrochemical Society may be arranged for autumn.

ELECTRICAL EQUIPMENT OF IRON WORKS.

Electrical engineers are doing a rapidly-increasing business in installing electric-power machinery in manufacturing establishments of England, espeically in the iron and steel trades. The new machinery and electric plant of Sir B. Samuelson & Co., Ltd., are now in steady and successful operation. Realizing the necessity of adopting the most approved methods of power transmission in these present times of keen competition, this company, an old and prosperous firm, have, during the past summer, installed an electric-transmission plant, including entirely new and modern apparatus, both in the driving appliances and the other machinery, in their works at Newport, in the outskirts of Middlesbrough, England. The contractors for the electrical-power installations are the British Westinghouse Electric and Mfg. Co.

The power is generated in the form of three-phase alternating currents by two steam-driven Westinghouse alternators of the rotating armature type. The steam engines run non-condensing, and at a normal speed of 400 R. P. M. Steam is supplied at a pressure of 150 pounds per square inch by four Babcock-Wilcox boilers. The boilers are heated by the waste gases from a battery of coke ovens alongside, being placed between the ovens and a lofty smokestack. The flues are duplicated and fitted with dampers and by-passes, so that any number of the boilers may be heated and regulated as required. Steam-driven pumps supply water from the Middlesbrough and Stockton water-supply system. Injectors are also fitted to each boiler, and a Berryman exhaust steam feed-water heater is included in the steam equipment.

The construction of these alternators insures the best of insulation being obtained, and also renders possible the easy examination and replacing of any single-armature coil without interference with the rest of the winding. The output of each generating set is 175 kilowatts at 440 volts pressure. All of the motors and the electric lighting are supplied direct from the machines. Although rated at 175 kilowatts, the alternators have a considerable overload capacity, and are able to maintain 25 per cent. overload for long periods and 50 per cent. overload for about an hour without undue heating or chance of injury of any kind. Each machine has an exciter, driven by belt from the outer end of the main shaft, and the two exciters being exactly similar and of the Westinghouse multipolar type, four-pole, and each has a capacity of 7½ kilowatts at 125 volts when running at a speed of 775 R. P. M. Each of these machines is capable of providing full exciting current for both alternators running at maximum rated load. The main switchboard consists of six white-marble panels, supported on wrought-iron framework, at a distance of 5 feet from the engine-room wall. There are two machine panels, one exciter panel and three feeder panels, all being fitted with the well-known type of instruments, switches, etc., that are usual in standard Westinghouse practice. The machine main circuits, and also the feeders, of each of the four sets are fitted with fuses. Each of the three feeder panels carries switches and fuse blocks for two sets, one feeder panel thus being available for extensions. The circuits are arranged for the parallel running of the main generators, which, with their exciters and switchboard, are housed in a new building erected for the purpose.

Electric power is used for the rapid handling and breaking of the coal, two motors being installed in the building set up for the accommodation of the coal breaker and elevator gear, these two machines working together and taking complete charge of the coal supply, reducing the labor item to a minimum. The capacity of this portion of the equipment is 50 tons of coal per hour. Another electric motor is installed in a shed at the base of the middle storage bin at the lower end of a conveyor belt, which carries the coal at the rate of about 25 to 30 tons per hour up an angle of 17 degrees. The fine coal is fed into the coke ovens through top doors from small wagons having collapsible bottoms, so as to permit of rapid work in charging. The coke is taken from the ovens by means of an electric ram through a vertical sliding door at each end of the ovens.

An electrically-operated overhead crane of 70-foot span travels over the full length of the casting bed, and has a lifting capacity of 4 tons, the power being received from three independent motors, giving a speed of 320 feet per minute. This crane lifts the cold pigs in "comb" pieces of 2 tons or more in weight direct from the casting bed, and carries them to an ingenious breaking machine installed on a raised brick platform. The pigs, as brought forward by the crane, are laid on a long iron table, which has a loose center, to which an undulating motion is given for lifting the long "comb" of the pig forward as it comes under a set of rams. Two rams descend and grip the outer sides of the pig by pressing it down onto the solid table; a middle ram follows, striking the hollow center of the pig and breaking it into three or four pieces. The pigs are broken into lengths of about 2 feet each, and fall down a short open chute into railway cars below. The breaking process and the wagon loading is continuous and automatic. Another ram behind those mentioned serves to break the sow piece as it gradually works its way forward from the gripping ram of that side. All the motions of this machine, both those of the tables and the rams, are produced by a single electric motor, which is coupled to the breaker through spur-reduction gearing.

The nine electric motors for the purposes described are all exactly similar in construction, and in every case, it is stated, have behaved remarkably well under unusually trying conditions. They are three-phase, alternating-current induction motors, of the widely-used Westinghouse type "C" form. This motor is chiefly remarkable for the mechanical simplicity which it combines with a high electrical economy and very low maintenance and operating expenses. With the exception of the three crane motors, which require to have a certain amount of regulation, the motors are each started by means of a double-throw switch, which may be some distance from the motor if desired.

The crane motors are started and regulated by means of Westinghouse commutator-type controllers. The set of these, for all three motors, is fixed in the operator's cage, which is suspended from the crane girders at the pig-breaker end, where the man in charge is in the most advantageous position for performing his work of laying pigs quickly and correctly on the breaker table. The controllers are simply designed on an extension of the principle of the starting switch mentioned, having a number of intermediate contacts for supplying various pressures to the motors.

The motor standing at the foot of the fine-coal storage bin works constantly in an atmosphere charged with coal dust, frequently being embedded in an accumulation of fine coal; and when it is cleaned out periodically a large quantity of coal is taken from it. Still it works constantly and well, never receiving any attention beyond a periodical cleaning and an occasional visit from a greaser. The two motors installed together for the operation of the coal breaker and the bucket elevators are subject to similar conditions as the one just mentioned, although to a somewhat less degree.

The motors working the coke rams are subject to high temperatures. The heat radiating from an open oven is very great, even at the distance the motor is away from the oven face. Yet these motors, as well as the crane motors, which are exposed to atmospheric elements and changes, perform the heavy duties required of them in a manner so satisfactory that it is not difficult to understand their individual reputation and the impetus they have given to the installation of electrical equipments throughout the world.

The power station is lighted by a number of incandescent lamps, arranged in pairs across the 440-volt supply mains. There are also 120 incandescent lamps and 12 arc lamps of the

inclosed type distributed in various parts of the works. The lighting system is about to be extended considerably.

The immediate effect of the electric crane and breaker for the handling of metal at the casting beds was the reduction of the staff to the extent of 23 men. The introduction of electrically-driven machinery has not necessitated the employment of new and highly-trained workmen. With the exception of the power station, where the steam plant and the control of the generators and circuits call for a certain amount of skilled labor, no work of attendance beyond the ability of the untrained man of ordinary intelligence is required. The men in charge of the electric plant have been drawn from the former staff.

This saving of labor, added to the economies of floor space, transmission, running losses and low lubrication common to all electrical power installations, has made the works of Sir B. Samuelson & Co. a model that might well be copied by his competitors.

OBITUARY.

A. T. WEIGHTMAN.

In our last issue we reported with regret the death of Mr. A. T. Weightman, formerly the chemist with the Electrical Reduction Co., of Niagara Falls. We herewith reproduce his portrait. Mr. Weightman was taken sick the last day of the Niagara Falls meeting of the American Electrochemical Society. His physician recommended him to resign his position at Niagara Falls and go to his home in England to recuperate. He went to London to undergo an operation, which resulted in his death on February 3d.

Personal.

Mr. Titus Ulke, the well-known electrometallurgist, has accepted a position with the Hyland Paper Co., Johnsonburg, Pa.

Mr. Charles S. Powell, who has been associated with the Westinghouse electric interests since 1893, and who, for the past six years, has been manager of the Cleveland office of the Westinghouse Electric and Mfg. Co., has changed the scene of his activities from the United States to Europe. He has been appointed assistant manager of the British Westinghouse Electric and Mfg. Co., Ltd., and has already entered upon the duties of his new position. His headquarters are in the Westinghouse Building, Norfolk street, Strand, London, W. C.

Prof. R. H. Thurston, of Cornell University, will lecture before the New York Electrical Society next month on steam turbines.

Mr. Robert R. Moffett, Bayonne, N. J., general superintendent of the Orford Copper Co., has been visiting the principal lead and copper smelters of the West.

Mr. John Stevenson, Jr., now general superintendent of the Sharon Steel Co., Sharon, Pa., will soon resign his position, in order to undertake an extensive trip abroad.

Mr. W. B. Mucklow, Hartford, Conn., of Chapman, Mucklow & Bosson, finanical agents for the Majestic Copper Mining and Smelting Co., has been in Utah with a large party of Eastern stockholders of the company.

TRADE CATALOGUES.

The Combination Rubber and Belting Co., Bloomfield, Essex County, N. Y., sent us their illustrated catalogue on vulcanized rubber goods adapted for mechanical purposes. Rubber tubing, to be used in connection with electric furnaces, is one of the specialties of this firm.

The Dayton Mfg. Co., Dayton, Ohio, have issued a new illustrated catalogue on the Silvey storage battery.

The Croftan Storage Battery Co., Toronto, Canada, sent us a fly leaf on their electrical automobile batteries.

The C. W. Hunt Co., West New Brighton, sent us their catalogue 0225 and pamphlet 0228 on electric hoists.

We received from the Sawyer-Man Electric Co., New York City, several fly leaves on the Sawyer-Man series railway lamp, high-voltage lamp, and reflector lamp.

The Boston Pottery Co. sent us their illustrated catalogue and price list No. 2, 1903, for all kinds of stoneware specialties, fine glazed ware, Rockingham and yellow ware and Bristol ware.

The E. T. Gleason Mfg. Co., New York City, have sent us their nicely-printed and profusely-illustrated catalogue on electric-light supplies.

INDUSTRIAL NOTES.

The Bullock Electric Co., Cincinnati, Ohio, have secured a motor contract from the Manaduta Mining Co., Japan.

Power Plant Development.—Mr. J. H. Robeling has completed the plans for the development of a water-power electrical plant at old Limekiln Falls in the town of Stockbridge, N. Y. The plans provide for two plants, one above the other, thus using the water twice, and the combined plants will furnish 2,000 horse-power. It is proposed to use the upper power house for supply for Syracuse, and the one on the flats for the use of Oneida and Canastota. Mr. Dewitt Hadcock, of Oneida, owns the water rights.

We are informed from Concord, N. H., that the Connecticut River Power Co. have been incorporated by Brattleboro men, with an authorized capital of $200,000, which may be increased to any sum not exceeding $1,000,000. The Legislature of New Hampshire will be asked for a similar charter. The company will push the project for a dam across the Connecticut River a short distance below the railroad yard in Brattleboro. It is expected to develop here one of the greatest water-powers in New England.

Mexico.—Lauro Barra, of Mexico City, has been granted a concession by the Mexican authorities for the purpose of constructing a hydro-electric plant on the Del Valle River, in the State of Mexico, at a point called Salitrillo, about 45 miles from the city of Toluca. The franchise permits of the use of 8,000 liters of water per second.——The Dos Estrellas Mining Co. are after a concession from the Mexican authorities to permit of the utilization of 25,000 liters of water per second from the River La Cienega. It is proposed to operate the company's reduction works by water-power and to furnish the mining town of Tlalpujahua, located in the State of Michoacan, with power for electric lighting use.——A 10,000 horse-power plant is to be constructed for the purpose of furnishing energy to operate several of the principal mines located in the El Oro district, Mexico. Jose Luis Reguena, one of the prominent mine owners in that section, has secured the requisite concession. The plant, which will be capable of developing 10,000 horse-power, will be built on the Lerma River. The current will be conveyed for a distance of about 80 miles.

Power-Transmission Plant for India.—The Federal Electric Co., 141 Broadway, New York, have taken a contract for the complete electrical equipment of a transmission plant to be constructed in India for the purpose of generating energy to be conveyed a distance of about 20 miles for both light and power

use. There will be two 150 kw, three-phase generators. The contract for the steam equipment has been awarded to a British concern on the plea of better prices and deliveries being obtained there at present.

THE A. LESCHEN & SONS ROPE CO., makers of wire rope and aerial tramways, have opened new offices at 920-922 North First street, St. Louis, Mo. They will be glad to have mining men passing through St. Louis make the office their headquarters while in the city.

THE RANSOM MFG. CO., Oshkosh, Wis., have obtained some fair-sized orders for grinding and polishing machinery for South America and Mexico.

THE GREAT NORTHERN PORTLAND CEMENT CO., Detroit, Mich., will equip their new plant throughout with electrical apparatus, and have recently purchased from the Westinghouse Electric and Mfg. Co. 23 direct-current motors, ranging in size from 5 horse-power to 50 horse-power. These motors will be applied to driving cement machinery of all kinds.

THE LLEWELLYN IRON WORKS, Los Angeles, Cal., are to be equipped throughout for driving by electric motors. Induction motors will be direct-coupled or belted to lathes, planers and other machinery, and line shafting will be entirely done away with. The Pacific Light and Power Co. have recently purchased from the Westinghouse Electric and Mfg. Co. for this plant 20 induction motors, ranging in size from 2 horse-power to 75 horse-power, which are now being installed.

THE CLEVELAND HARDWARE CO. are installing a complete electrical equipment for the operation of their plant, and have recently purchased from the Westinghouse Electric and Mfg. Co. one 75 kilowatt and one 100 kilowatt, two-phase alternators, together with exciters, switchboard, ten 20 horse-power motors and two 10 horse-power motors. The plant is already in operation, and is doing very satisfactory work. Geo. S. Rider & Co. are the engineers.

THE TERRENATES CONSOLIDATED MINING CO., Parral, Mex., have placed a contract with the Denver Engineering Works, Denver, Colo., for the installation of a complete plant for the transmission of 600 horse-power to be used for the operation of hoisting and pumping machines. Steam turbines to be built by the De Laval Steam Turbine Co., New York City, will furnish the current, which is to be conveyed by means of aluminium conductors to the hoists and pumping stations, about 1½ miles. Frank B. Rae, of New York City, consulting engineer of the Terrenates Co., will have charge of the work.

THE BISHOP & BABCOCK CO., Cleveland, Ohio, are equipping their machine shop for electric driving. The group system has been adopted and short lengths of line shafting throughout the shops are driven by Westinghouse induction motors. Seven or eight of the latter, ranging in size from 10 horse-power to 40 horse-power, have been purchased and are now in operation, current being temporarily supplied from the plant of the Cleveland Twist Drill Co., who are also equipped with Westinghouse apparatus. The Bishop & Babcock Co., however, are installing a power plant of their own, and have recently purchased a 175-kilowatt, two-phase, Westinghouse, engine-type alternator, with switchboard complete. Geo. S. Rider & Co. are the engineers for the plant.

GENERAL ELECTRIC-STANLEY.—It is stated that the much-discussed deal between the General Electric and Stanley interests has been closed, but does not include the Electric Storage Battery Co., as had been expected. The Pittsfield works of the Stanley Co. will be carried on as usual, special attention being given to high-voltage polyphan apparatus.

NATIONAL CARBON REPORT.—The annual report of the National Carbon Co. shows that the company's assets February 1, 1903, amounted to $10,324,028.88, of which $9,270,000 was in real estate, plants, machinery, etc.; $448,215.57 in merchandise, manufactured and unmanufactured, and $364,601.51 in bills and accounts receivable. The liabilities include: Preferred stock, $4,500,000; common stock, $5,500,000; accounts payable, $89,278.01, and profit and loss, $156,000.87. The net earnings of the company for the fiscal year ended January 21st were $594,371.76.

GOULD STORAGE BATTERY CONTRACTS.—Among the recent contracts closed by the Gould Storage Battery Co. are the following: Philadelphia and Lehigh Valley Traction Co.; battery to be located near Quakertown, Pa.; 196 cells in glass jars and switchboard; discharge capacity, 200 ampères. Warren Electric Street Railway Co., Warren, Pa.; 240 cells in glass jars, switchboard and Gould regulating booster; discharge capacity, 160 ampères. Dayton and Muncie Traction Co., 4 plants, located at Winchester, Ind.; Selma, Ind.; Union City, Ohio; Greenville, Ohio; each battery consisting of 305 cells in lead-lined tanks; plate capacity, 320 ampères; tank capacity, 400 ampères; switchboard and 44-kilowatt regulating Gould booster. Odell Illuminating Co.; battery located at Odell, Ill., consisting of 124 cells in jars; capacity, 240 ampère-hours at 240 volts, for three-wire lighting system. Manhattan Heat, Light and Power Co.; battery located at St. Paul, Minn., consisting of 56 cells in lead-lined tanks; capacity, 2,080 ampère hours; switchboard and automatic Gould booster for block lighting and regulation.

THE new plant of the Osceola Silica and Fire Brick Co. at Osceola Mills, Clearfield, County, Pa., will be ready early in April. The plant will have an output of 25,000,000 fire brick annually, while a large output of silica brick has also been provided for. The company were recently incorporated with $100,000 capital. Charles Rowland is president; H. W. Todd, treasurer, and R. L. Coffey, secretary and general manager.

THE WESTON ELECTRICAL INSTRUMENT COMPANY ESTABLISH A NEW YORK OFFICE.

For the greater convenience of their numerous customers and to better care for the continued increase of business in New York and vicinity, the Weston Electrical Instrument Co., Waverly Park, Newark, N. J., have opened a New York office, at 74 Cortlandt street. This office will be under the management of Mr. Caxton Brown, who has a theoretical as well as a practical knowledge of the different instruments manufactured by the Weston Co. and their particular adaptabilities. This will enable any purchaser or any person visiting or doing business in New York, who may wish to make inquiries relative to electrical measuring instruments, to come in direct contact with a man who is properly qualified to answer such inquiries.

There will be a show room in connection with the New York office, in which will be exhibited the different types of Weston instruments and their special advantages; also the individual parts which make up the instruments. Besides being a great convenience to customers, the New York office will eliminate much correspondence in the nature of inquiries, thus reducing time of delivery of orders.

A general impression has prevailed that the Weston Electrical Instrument Co. only made voltmeters and ammeters, which is not the case. Having what are credited with being the largest and best-equipped works in the world for the production of electrical measuring instruments of all kinds, the company are particularly fitted to turn out work of any special character in which the highest excellence of mechanical and electrical work and design are the important features.

They have, in fact, been turning out a large amount of special laboratory apparatus for several years past, and are now prepared to make standard cells, standard resistances, galvanometers and the highest grade of special bridge work, speed indicators, etc.

The Weston Electrical Instrument Co. extend a cordial invitation to all interested in the subject of electrical measurements to make use of their New York office, either for the purpose of inquiry on the technical points involved or for the prospective purchasing of instruments.

DIGEST OF U. S. PATENTS PRIOR TO JULY, 1902.

Compiled by Byrnes & Townsend, Patent Lawyers, National Union Building, Washington, D. C.

This digest of electrochemical United States patents prior to July, 1902, will be one by classes, setting out for comparison in each class those devices which have the same object, or those methods which seek the same results. In each class the patents will be arranged chronologically. The digest will be complete in the sense of covering every point which is touched upon in the original specification.

564,311. July 21, 1896; James Mercer, Rumford Falls, Me.

Anode compartment, a pottery cup with vertical slots through lower half, surrounded by a winding of asbestos paper. Wire gauze cathode clamped around asbestos. Cup has a side opening and reservoir for feeding salt and indicating level of electrolyte within; also a cover sealed by water or oil.

571,591. November 17, 1896; James Hargreaves, Farnworth-in-Widnes, and Thomas Bird, Cressington, England.

Electrolyses sodium nitrate, potassium iodide, etc. Cell built up of a series of frames, between which are clamped diaphragms of asbestos or glass cloth, impregnated with barium or strontium sulphate. Frames of anode compartments, pottery or glass. Frames of cathode compartments, metal, serving as terminals for cathodes. Electrolyte in second, fourth, sixth, etc., compartments only. First, fifth, ninth, etc., compartments contain exposed anodes of wire gauze or perforated plates of carbon with serrated faces, clamped against diaphragms. Third, seventh, eleventh, etc., compartments contain exposed cathodes of wire gauze or perforated metal. Introduces steam into anode compartments to volatilize and remove iodine, nitric oxide or other anion. May also run water down between anodes and diaphragm. Washes off cathode products by a water spray.

579,250. March 23, 1897; Elbridge Baker, Winchester, Mass.

Diaphragm cell, comprising a barrel or cask lined with a mixture of sand and cement. Transverse, vertical central diaphragm, also of sand and cement. Mixture contains only sufficient cement to bind the particles of sand. Feeds salt to anode compartment; brine to cathode compartment. Anode, pieces of retort carbon strung on a copper rod and joined by cement, lead being cast between the rod and the carbon pieces.

583,330. May 25, 1897; Ernest Arthur Le Sueur, Ottawa, Can.

Supplies hydrochloric acid to the anode compartment to neutralize the caustic which diffuses through the diaphragm.

586,236. July 13, 1897; L. P. Hulin, Modane, France.

One or both electrodes, a porous plate or tube, through which the electrolytic products escape, to prevent recombination. Such "filter electrode" may be of porous carbon, spongy or porous metal, a grid filled with "powders suitably agglomerated or of porous or spongy substances of the kind used in electrodes for secondary batteries," or thin, superposed metal strips or rings. Behind each "filter electrode" is a receiving compartment for the electrolytic products, which may be entirely drained or allowed to partly or entirely fill and overflow. When the level of liquid in the electrolyzing compartment is higher than in the receiving compartment, cover upper portion of active face of electrode with a rubber sheet, which extends just below the level in the receiving compartment. Electrodes may be vertical or horizontal, and may be set into and subdivide a rectangular vessel or be clamped between separate frames. Constant feed to electrolyzing compartment assists in pressing electrolytic products through electrode. May also maintain a vacuum in receiving compartment. May or may not use a diaphragm between electrodes. Examples of electrolytic products: caustic potash escaping through porous cathode and sulphuric acid escaping through porous anode.

596,157. December 28, 1897; J. Hargreaves, Widnes, England.

Cell consists of three compartments, parallel diaphragms of asbestos paper, impregnated with hydrated calcium or magnesium silicate, being clamped between an intermediate non-conducting frame and outer receiving chambers of cast iron. Anodes, a row of vertical carbon rods between the diaphragms. Cathodes, exposed sheets of copper-wire gauze clamped against outer faces of diaphragms. Sodium oxidized and washed off cathodes by steam injected into the outer compartments, which are empty. Carbon dioxide—*e. g.*, the exhaust of a gas engine or furnace—may be introduced with the steam to carbonate the product. To electrolyze ammonium sulphate, employs submerged cathodes and exposed anodes of platinum-wire gauze or serrated or perforated carbon plates, clamped against outer faces of diaphragms, the sulphuric acid being washed off. May heat cell to assist in driving off the ammonia gas.

606,981. July 5, 1898; W. S. Romme, New Rochelle, N. Y.

Electrolyses, a moistened layer of salt resting upon a perforated cathode, such as a sheet of zinc. Anodes, horizontal carbon rods in the body of salt. Constantly supplies enough water by means of perforated pipes to keep the salt moistened and wash the caustic down through the cathode. Supplies salt to the moistened layer by angular revolving grate bars above. May place a perforated tray containing lime in upper part of cell to absorb chlorine.

612,009. October 11, 1898; G. B. Baldo, Triest, Austria-Hungary.

Electrolyses sea water to produce caustic soda, hydrogen, chlorine, oxides of magnesium and calcium and sulphuric and hydrochloric acids. Employs two concentric, porous-cup diaphragms. Outer cup consists of a skeleton frame of earthenware, with superposed layers of linen, asbestos board and wire netting serving as cathode. Inner cup consists of a skeleton frame of earthenware, with superposed layers of linen, asbestos board and linen. Anodes, carbon bars in inner cup. Fills inner cup and space between cups with sea water, the space between outer cup and containing vessel being filled with fresh water. Says that magnesium and calcium oxides are precipitated between the cups. Sulphuric acid liberated at anodes, decomposing sodium chloride and producing hydrochloric acid, which is subsequently distilled off. Caustic solution drawn from containing vessel. May fill inner cup with dilute sulphuric acid, thus obtaining sulphuric acid and chlorine only as anode products.

637,410. November 21, 1899; G. H. Pond, Ashburnham, Mass.

Electrolytic cell supported transversely in the middle of an enclosure or casing, which it subdivides into two compartments. A transverse partition depends from the casing into the cell. A diaphragm of sandstone, gradually thickening toward the bottom, may extend from the partition to the bottom of the cell. Anode and cathode, plates of carbon and iron, pressed against pins projecting from walls of cell by a body of moistened salt, which is packed between them. Brine fed to salt by separate wicks leading from reservoirs to inner face of anode and cathode. Caustic solution and chlorine water run out through side openings at the bottom. Superposed perforated trays, containing lime, are placed in the casing outside the anode compartment of the cell to absorb chlorine.

637,851. November 28, 1899; H. Carmichael, Malden, Mass.

A tilting, pipe-shaped device for delivering brine from a reservoir to the cell of patent 518,710, Fig. 10.

641,820. January 23, 1900; W. Barnes, Lynn, Mass.

Maintains a vacuum over electrolyte. May electrolyze ammonium chloride and separately exhaust ammonia and chlorine. Cell may have a diaphragm, *e. g.*, a board having a rectangular opening closed by a block of superposed asbestos sheets. Float feed regulators, with insulated couplings, deliver electrolyte from reservoirs to cell. May introduce electrolyte through a hollow, cylindrical, perforated, revolving electrode.

(To be continued.)